ANATOMICAL VARIATIONS OF TENTORIAL VENOUS SINUS IN 100 CASES OF AUTOPSY

DISSERTATION SUBMITTED FOR

MASTER OF CHIRURGIE – BRANCH II

NEUROSURGERY – 3 YEARS

THE TAMILNADU DR.M.G.R MEDICAL UNIVERSITY

CHENNAI

TAMILNADU

AUGUST 2010

ANATOMICAL VARIATIONS OF TENTORIAL VENOUS SINUS IN 100 CASES OF AUTOPSY

DISSERTATION

Submitted to THE TAMILNADU DR. M.G.R. MEDICAL UNIVERSITY

in partial fulfillment of the requirement for the award of degree

MASTER OF CHIRURGIE - BRANCH II

NEUROSURGERY - 3 YEARS

August 2010

MADURAI MEDICAL COLLEGE
Madurai

THE TAMILNADU DR.M.G.R MEDICAL UNIVERSITY

CHENNAI

CERTIFICATE

This is to certify that this dissertation titled **"ANATOMICAL VARIATIONS OF TENTORIAL VENOUS SINUS IN 100 CASES OF AUTOPSY"** is an original bonafide work conducted by **Dr.L.SANKAR** at Madurai Medical College, Madurai under my guidance and supervision.

The DEAN,	**Prof.Dr.N.ASOKKUMAR, M.Ch.,**
Madurai Medical College,	**Professor and Head of Department,**
Madurai.	**Department of Neurosurgery,**
	Madurai Medical College,
	Madurai.

DECLARATION

I solemnly declare that this dissertation **"ANATOMICAL VARIATIONS OF TENTORIAL VENOUS SINUS IN 100 CASES OF AUTOPSY"** was prepared by me under the guidance and supervision of Professor & HOD, Department of Neurosurgery, Madurai Medical College and Government Rajaji Hospital, Madurai between 2007 and 2010.

This is submitted to The Tamil Nadu Dr. M.G.R. Medical University, Chennai, in partial fulfillment of the requirement for the award of MASTER OF CHIRURGIE, NEUROSURGERY, degree Examination to be held in AUGUST 2010.

Place: Madurai.

Date :

Dr. L.SANKAR

ACKNOWLEDGEMENT

I thank with gratitude, **The DEAN**, Madurai medical college, Madurai for permitting me to utilize the clinical materials of this hospital.

I am gratefully indebted to **Prof.Dr.N.Asokkumar, M.Ch.**, Head of Department, Department of Neurosurgery for the valuable guidance, advice and inspiration rendered in this study.

I acknowledge the guidance and support given by **Prof.Dr.N.Muthu Kumar, M.Ch.,** to complete the study successfully.

I wish to express my sincere thanks to **Prof.Dr.S.Manoharan, M.Ch.,** and **Prof.Dr.D.Kailairajan, M.Ch.,** for their guidance and help during this study.

I am thankful to all assistant professors of my department and Professor of Forensic Medicine, **Dr.G. Natarajan M.D.** for their encouragement and guidance to complete the study.

Finally I would like to extent my heart felt appreciation to my parents and wife who assisted me in every way in preparing this study.

CONTENTS

INTRODUCTION

The presence of venous sinuses within the tentorium cerebelli is not mentioned in standard textbooks of neuroanatomy[1]. Gibbs and Gibbs[2], in their study on the torcular and lateral sinuses, seem to have been the first to describe tentorial sinuses. Since then it was subsequently studied by many anatomist, neurosurgeon and radiologist.

Certain neurosurgical procedures such as transoccipital transtentorial, infratentorial supracerebellar, and subtemporal transtentorial approaches require sectioning of the tentorium. The presence of venous sinuses within the tentorium makes these procedures difficult. Knowledge of their anatomy is important to decide the direction of incision and appropriate method of hemostasis to reduce venous congestion and bleeding.

AIM OF STUDY

The aim of study is

1. To determine the incidence of venous sinuses within the tentorium cerebelli.
2. To identify the location, configuration and size of the sinuses within the tentorium.
3. To know the pattern of drainage of these sinuses.

MATERIALS AND METHODS

This anatomical study of tentorial venous sinus is a cadaveric study. Cases excluded from the study are

1. Head injury
2. Intracranial pathology
3. Accidental distortion during dissection

In this study, 100 human cadaveric brains of both male and female that underwent autopsy with in 12-48 hrs after death were studied. Skull cap was opened in circular manner. The frontal lobes were lifted after opening the duramater and the anterior falx was cut. The brain stem was cut axially just above the level of tentorial insisura.

The cerebral hemispheres were removed and the tentorium was inspected macroscopically for the presence of venous sinuses. The size, configuration, location, and pattern of venous drainage were noted. Subsequently, the brain stem and cerebellum were removed through the tentorial incisura, and the tentorium was inspected again. This was performed to avoid confusing the veins on the surface of the cerebellum with venous sinuses, which was possible especially when the tentorium was thin. In addition, the tentorial sinus was opened, and a probe was passed inside to confirm its presence.

An imaginary line drawn horizontally at the junction of the superior petrosal sinus and transverse sinus was used to divide the tentorium arbitrarily into anterior and posterior portions. And again the tentorium was arbitrarily divide into medial one-third, middle one-third, lateral one-third on relation to the transverse sinus.

REVIEW OF LITERATURE

Anatomy of the Tentorium cerebelli

The tentorium is a membrane which covers the cerebellum[3]. It separates the cerebrum from the cerebellum. The term tentorium was first coined by Winslow. He called it as la tente[4]. Tent means something covers rather than supports.

The tentorium is attached to temporal, occipital, and sphenoid bones. All of the tentorial margins, except the free edges bordering the incisura, are rigidly attached to the cranium[5]. The anterior border is attached to the petrous ridge. The lateral and posterior borders are attached to the inner surface of the occipital and temporal bones along the internal occipital protuberance and to the edges of the groove for the transverse sinus[5].

The anterior end of each free edge is attached to the petrous apex and the anterior and posterior clinoid processes.

The attachment to the petrous apex and the clinoid processes forms three dural folds: the anterior and posterior petroclinoid folds and the interclinoid fold. Between these folds the oculomotor trigone is located, through which the oculomotor and trochlear nerves enter the sinus. The posterior petroclinoid fold extends from the petrous apex to the posterior clinoid process[5].

The anterior petroclinoid fold extends from the petrous apex to the anterior clinoid process; The interclinoid fold covers the ligament extending from the anterior to the posterior clinoid process. The oculomotor nerve penetrates the dura in the central part of this triangle, the oculomotor triangle, and the trochlear nerve enters the dura at the posterolateral edge of this triangle.

The petro sphenoid ligament passes between the leaves of the posterior petroclinoid fold from the petrous apex to the lateral border of the dorsum sellae, just below the posterior clinoid process[6]. The abducens nerve passes below the petro sphenoid ligament to enter the cavernous sinus.

From the anterior part of the free edge, the dura mater slopes steeply downward to form the lateral wall of the cavernous sinus and to cover the middle cranial fossa. The attachment of the anterior end of the free edge to the petrous apex may be situated as much as 10 mm lateral and 8 mm below the level of the clinoid processes[7].

The low position of the free edge may facilitate descending tentorial herniations. The falx cerebri fuses into the dorsal surface of the tentorium in the midline behind the apex. The straight sinus is enclosed in the falcotentorial junction. It begins at the tentorial apex, where it receives the vein of Galen and of the inferior sagittal sinus, and terminates in the torcular sinus.

Embryology of Tentorial venous sinus

Based on literatures tentorial venous sinuses may be formed by any one of the ways described below.

By the end of the first month of gestation, when the embryo is approximately 5 to 8 mm in length, the neural tube is surrounded by a primitive capillary plexus throughout its length. The rostral portion of the neural tube from which the brain arises is drained by three dural plexuses, as follows: 1) the anterior plexus, which drains the forebrain (telencephalon and diencephalon); 2) the middle plexus, which drains the pons and the cerebellum (metencephalon); and 3) the posterior plexus, which drains the medulla (myelencephalon).

These plexuses drain over the dorsal aspect of the neural tube and enter the dorsal aspect of the primary head sinus. By the 14-mm stage, the tentorial sinus (to be differentiated from the postnatal structure of the same name), located at the caudoventral portion of the cerebral hemispheres, terminates in the stem of the anterior dural sinus.

During the 24-mm stage, the tentorial sinus gains prominence as the stem of the anterior dural plexus dwindles and/or disappears. It serves as the major drainage for the largest vessels of the cerebrum, including the middle cerebral veins, as well as the diencephalon and corpus striatum before the formation of the basal cerebral vein.

The tentorial sinus as described here, however, may have a protracted existence developmentally and may endure permanently [7]. The relationship between the tentorial sinus of adults and that of the human embryo is not firmly established[8]. However, as suggested by Lasjaunias and Raybaud[9], the tentorial sinus described above probably represents one of the several possible modes of persistence of the embryonic arrangement.

During the 24-mm stage, are grouped together as the tentorial plexus. This plexus occupies the wedge of the mesenchyme (the primitive tentorium cerebelli) located between the enlarging cerebrum and cerebellum. As the cerebral hemispheres expand and overgrow the developing diencephalic and mesencephalic areas, the tentorial plexus is gradually reduced. Ultimately, it is represented by the torcular or confluens of sinuses[7]. The venous sinuses in the tentorium may represent the persistent remnants of the primitive tentorial venous plexus.

Okudera et al.[10] reported that until the age of 4 1/2 fetal months, the transverse sinus has a relatively even caliber. At this stage, it begins to enlarge from its lateral border on each side.

This enlargement or ballooning rapidly progresses medially and reaches the torcular sinus approximately 1 to 1 1/2 months later. This ballooning is most conspicuous by the 5th fetal month and may further extend into the posterior portion of the superior sagittal sinus and superior petrosal sinuses. At the age of 7 fetal months, enlargement of the sinus practically ceases.

Rapid increase and decrease in the inner diameter of the transverse sinuses frequently results in irregular inner diameters and irregular margins of the transverse sinus. Pouches of the dural sinus may be formed and may extend from the transverse sinus into the convexity dura or the tentorial dura. These pouches may receive cortical veins from the convexity or from the undersurface of the temporo-occipital lobes.

Because most of the tentorial venous sinuses encountered in this study were observed to drain into the torcular herophili, transverse sinus, and the junction of the transverse sinus and superior petrosal sinus, it is possible that they may represent outpouching of the transverse sinus[10].

Okudera et al. provided an explanation for this occurrence. Beginning at 4 1/2 to 5 fetal months, the superficial cortical veins of the expanding cerebral hemispheres rapidly increase in size and drain into the transverse sinus on each side. This corresponds to the period of ballooning of the transverse sinuses and to the rapid increase in the total blood draining into the transverse sinuses. On the other hand, the junctional area of the sigmoid sinus and jugular vein is poorly developed; their inner diameters range from 1 to 2 mm until the age of 7 fetal months.

The narrow internal lumina of the sigmoid sinuses and the internal jugular veins, particularly at their junctions (which Okudera et al. named as the jugular sinuses), results in physiological intraluminal venous hypertension, secondary ballooning of the transverse sinuses, and enlargement and some formation of multiple emissary veins for better extracranial drainage (formation of physiological collateral channels).

The formation of dural outpouches was considered by Okudera et al.[10] as another outcome of ballooning and the later decrease in the diameter of the transverse sinuses. These dural outpouches may involve the convexity dura or the tentorium cerebelli.

Therefore, they thought that, in some cases, a cortical vein or veins indirectly join the transverse sinus through a small tentorial sinus. During the present study, we noticed several cadavers with outpouching of the transverse sinus into the convexity dura. Most of these outpouchings of the transverse sinus were located in the medial one-third close to the torcular sinus. However, there was no apparent relationship between the outpouching of the transverse sinus and the presence, location, size, or configuration of the tentorial venous sinuses.

Anatomy of Tentorial venous sinus

Gibbs and Gibbs, in their study on the torcular and lateral sinuses, seem to have been the first to describe tentorial sinuses. They observed two sinuses in the tentorium which received blood from the superior cerebellar veins and emptied into the transverse sinus near the straight sinus. After their report, the tentorial sinuses were noted in studies of the dural sinuses near the torcular sinus.

Each half of the tentorium has two constant but rarely symmetrical venous channels, the medial and lateral tentorial sinuses[11]. The medial tentorial sinuses are formed by the convergence of veins from the superior surface of the cerebellum, and the lateral tentorial sinuses are formed by the convergence of veins from the basal and lateral surfaces of the temporal and occipital lobes.

The lateral tentorial sinuses arise within the lateral part of the tentorium and course laterally to drain into the terminal portion of the transverse sinus. The medial tentorial sinuses course medially to empty into the straight sinus or the junction of the straight and transverse sinuses.

Variations of the tentorial sinus in cerebellar tentoria of 13 cadavers were examined under a surgical microscope by Matsushima et al[12] and classified the tentorial sinuses into four groups: Group I, in which the sinus receives venous blood from the cerebral hemisphere; Group II, in which the sinus drains the cerebellum; Group III, in which the sinus originates in the tentorium itself: and Group IV, in which the sinus originates from a vein bridging to the tentorial free edge. The tentorial sinuses of Groups I and II were frequently located in the posterior portion of the tentorium.

The sinuses of Group I were short and most frequently present in the lateral portion of the tentorium. The tentorial sinuses of Group II, which were usually large and drained into the dural sinuses near the torcular, were separated into five subtypes according to the draining veins and direction of termination.

The tentorial sinuses of Groups III and IV were located near the tentorial free edge or the straight sinus.

Group I: Tentorial sinuses draining the cerebral hemisphere

Several cerebral veins usually converged at the superior surface of the cerebellar tentorium to form bridging veins. They were frequently present in the posterolateral part of the tentorium or near the transverse sinus. Most formed a short tentorial sinus draining into the large dural sinus, and the rest drained into the sinus through a converging stem vein.

The locations of the sinuses and the converging stem veins were classified into the medial, middle, and lateral third of the tentorium. 62.2% were situated in the lateral portion of the tentorium. These veins drained the basal surface of the temporal and occipital lobes, including the vein of Labb6 from the lateral surface of the temporal lobe.

Group II: Tentorial sinus draining the cerebellum

Bridging veins from the cerebellar tentorial surface to the tentorium often formed a tentorial sinus, which eventually drained into the torcular or the dural sinus nearby. On the lateral tentorial cerebellar surface, the inferior and superior hemispheric veins joined and formed bridging veins to drain into the tentorial sinus. Near the midline, some of the veins converging in the posterior cerebellar incisura drained into a short tentorial sinus after forming a bridging vein . Because the tentorial sinuses of Group II were frequently present as a large sinus, they were separated into five subtypes according to their draining veins and the direction of termination .

In Type 1, the sinus courses transversely to drain into the straight sinus. In Type 2a, the sinus drains the medial cerebellar hemisphere and courses posteromedially to drain into the torcular sinus. In Type 2b, the sinus draining the vermis is short and in a manner similar to the Type 2a sinus. In Type 3, the sinus draining most of the cerebellar hemisphere courses directly posteriorly to the middle one-third of the transverse sinus. In Type 4, the sinus drains the lateral tentorial cerebellar surface then runs posterolaterally to drain into the junction of the superior petrosal and transverse sinuses. All of the Group II tentorial sinuses were present in the posterior half of the cerebellar tentorium.

The bridging veins draining into the tentorial sinus of Group II were of two kinds: the vermian bridging vein on the vermis in the midline and the hemispheric bridging vein located on the lateral cerebellar surface. Most of the former veins were the terminal portions of the inferior vermian vein. Hemispheric bridging veins, formed by the joining of the inferior and superior hemispheric veins, were found in 80% of 20 sides.

These hemispheric bridging veins were less frequently located in the lateral one-third of the hemisphere than in the middle and medial one-thirds.

Group III: Tentorial sinus arising in the tentorium

The tentorial sinuses originating in the tentorium were present near the tentorial free edge or the straight sinus These were small sinuses with no bridging veins, and drained in two different directions. One type was a tentorial sinus originating from the posterior part of the tentorial incisura and running anteriorly along the tentorial edge to drain into the superior petrosal sinus. The other originated near the incisura and ran posteriorly along the straight sinus to drain into the posterior portion of the straight sinus or the torcular sinus.

Group IV: Tentorial sinus formed by a bridging vein to the tentorial free edge

A rarer type of tentorial sinus was described in two cases. In one, the basal vein of Rosenthal terminated as a bridging vein to the tentorial free edge, forming a tentorial sinus. The sinus ran posteriorly from the tentorial edge to the torcular, almost parallel to the straight sinus. In the other case, the peduncular vein running on the midbrain became a bridging vein to the tentorial edge forming a short tentorial sinus which coursed laterally to drain into the superior petrosal sinus.

Surgical significance of Tentorial venous sinus

The tentorium cerebelli is frequently sectioned to access deep seated lesions[13,14,15]. During these procedures, the venous sinuses within the tentorium might have to be occluded and divided. In most instances, this occlusion has no adverse consequences because of the inherent tendency of the venous system to contain collateral pathways.

However, when the main venous channels have been occluded by disease processes, these sinuses within the tentorium may act as important collateral channels for venous outflow and, in such circumstances, occlusion and division of these sinuses may have adverse consequences.

This has been amply illustrated by a number of case reports. Browder et al.[16] and Kaplan were the first to realize and hypothesize the importance of the venous channels within the tentorium as potential collateral pathways when the straight sinus was occluded.

In the occipital transtentorial operative approach, the occipital pole can usually be retracted from the straight sinus and the junction of the falx and the tentorium without sacrificing any veins to the superior sagittal or transverse sinuses.

The superior sagittal sinus is commonly devoid of bridging veins in the area just in front of the torcular herophili, but bridging veins are encountered if the exposure is directed further forward along the superior sagittal sinus in the posterior parietal area. The posterior calcarine vein, which empties into the veins on the lateral surface and into the superior sagittal sinus 4 to 9 cm proximal to the torcular herophili, is infrequently encountered in the occipital transtentorial approaches.

However, the anterior calcarine (internal occipital) vein, which crosses at a much deeper level, frequently blocks access to the quadrigeminal cistern as it passes from the anterior end of the calcarine fissure to the great vein, thus making its obliteration unavoidable in reaching some tumor in the pineal region. Sacrificing the anterior calcarine vein may cause a homonymous hemianopsia. No bridging veins pass directly from the occipital lobe to the straight sinus.

The medial and lateral tentorial sinuses may be encountered in the operative approaches in which the tentorium is divided. The medial tentorial sinus would be encountered in incising the tentorium from anterior to posterior adjacent to the straight sinus, as might be conducted in an occipital transtentorial or infratentorial supracerebellar approach. The lateral tentorial sinus would be encountered in the lateral part of an incision in the tentorium extending from the free edge toward the transverse sinus in the area just behind the petrous ridge, as would be conducted in a subtemporal approach to the front of the brainstem.

The veins that arise on the brainstem and cerebellum and drain into the superior petrosal sinus are also encountered in sectioning the anteromedial edge of the tentorium through a subtemporal craniectomy to expose the trigeminal nerve. The temporobasal bridging veins, which have relatively strong adhesions to the dura mater of the middle fossa and the superior surface of the tentorium, could be injured proximal to their termination during elevation of the temporal lobe in the course of a subtemporal operative approach to the basal cisterns.

Yamamota [17]described the advantages of occipital transtentorial approach over other approaches to pineal region

1. Wide operative field
2. No veins crossing from occipital lobe into superior sagittal sinus
3. Easy visualization of deep venous structure
4. Largely extra-axial above the tentorium
5. Good visualization of ipsilateral dorsal and lateral extension

Ziyal et al reported the combined supra/infratentorial-transsinus approach is preferred for the resection of certain large pineal region tumors. During the procedure, the transverse sinus and tentorium were sectioned after review of preoperative angiographic studies, after taking intraoperative measurements of the venous pressure in the nondominant transverse sinus before and after clipping and while monitoring the somatosensory evoked potentials.

Nagashima et al.[18] reported a case of hemangiopericytoma involving the torcular herophili and the straight sinus. The tumor was totally resected, with a radial artery graft interposed between the straight sinus and transverse sinus. However, during surgery, they noted swelling of the occipital lobe even in the presence of a functioning bypass graft. This swelling eventually necessitated occipital lobectomy.

They suggested that in the presence of occlusion of the torcular herophili and the straight sinus, the venous channels in the tentorium might have been the collateral channels and the wide resection of the tentorium might have caused the brain swelling.

Nakagawa et al.[19] reported a case of papillary meningiomas arising from the confluens of the sinuses, with extension into the sagittal, straight, and both transverse sinuses. They noted that, in such cases, the normal hemodynamic state is maintained by collateral circulation through venous channels in the tentorium and that care needs to be taken not to sacrifice this collateral circulation.

Odake[20] reported two falcotentorial meningiomas with occlusion of the straight sinus and emphasized the importance of preserving the collateral venous pathways in the tentorium.

Commenting on Odake's article, Morgan also reiterated the importance of preserving the collateral venous pathways when the major venous sinuses were occluded[21]. The importance of these collateral venous channels in falcotentorial and peritorcular meningiomas has also been adequately highlighted by several other authors, including Asari et al.[22], Harsh and Wilson , Rostomily et al.[23], and Tanaka et al.[24].

Piatt repored that simultaneous compromise of the galenic and tentorial bridging veins and interruption of collateral pathways between these systems and the petrosal bridging veins, as in the combined infratentorial supracerebellar / cerebellomedullary fissure approach, may cause cerebellar venous insufficiency with venous congestion and possible venous infarction.

Importance of Tentorial sinuses in vascular lesions

The tentorial venous sinuses may have a significant role in certain vascular diseases of the brain. Girard et al.[25] and Lasjaunias et al. noted that when the vein of Galen was absent, there emerged two distinct pathways of drainage of the deep venous system, one of which consisted of the thalamostriate veins draining into the tentorial sinus.

While studying the role of dural anomalies in the pathogenesis of vein of Galen malformations, Lasjaunias et al.[26] noted that, in the absence of a straight sinus, a tentorial sinus often bridges the vein of Galen to the torcular herophili. This is especially important because of the recent reports of a high incidence of straight sinus agenesis in vein of Galen aneurysms and in deep seated cerebral AVMs[27].

Raybaud et al.[28] reported that in certain patients with vein of Galen aneurysms, the lateral and sigmoid sinuses were not visualized, and the blood drained through the tentorial and petrosal sinuses into the cavernous sinus. Some extrasinusoidal dural AVMs are thought to develop from the remnants of the tentorial sinuses.

Duckwiler[29], Houser et al.[30] and Lasjaunias et al. have reported that the dural AVMs located in the tentorium may drain via the venous channels in the tentorium.

Zhou et al. reported five cases of tentorial arterio venous fistulas and classified the tentorial arterio venous fistulas into three types;tentorial marginal, tentorial medial and tentorial lateral. He considered the tentorial dural arteriovenous fistulas are aggressive vascular lesions causing SAH and progressive neurologic deficits and need prompt diagnosis and definite treatment.

The findings of Vidyasagar[31] have demonstrated that, in many AVMs of the brain, there are many venous channels that do not resemble known anatomic channels. He postulated that these channels are persistent embryonic veins that do not undergo atresia during development because of the persistence of flow through them. He reported that in AVMs in the region of the sylvian fissure, one of the abnormal venous drainage channels represents the persistent primitive tentorial sinus.

Ruaz et al reported a case of bilateral collateral tentorial venous sinus drainage of the basal vein (of Rosenthal). The observation was made on a corrosion cast of the cerebral venous system obtained from a fresh cadaver. Radiographic correlation was obtained by performing standard X-ray imaging of the corrosion cast.

During development, the tentorial sinus receives blood from the developing diencephalon, telencephalon, and mesencephalon. However, this drainage is later taken over by the basal vein. In AVMs, there may be persistence of these primitive pial veins that may drain into tentorial sinuses.

Terbrugge and Lasjaunias reported the radiological and anatomic features of a tentorial venous sinus that they encountered incidentally during a four-vessel angiogram. This sinus drained the telencephalic and diencephalic tributaries of the basal vein and eventually emptied into the straight sinus and the confluence of the sinuses.

They also mentioned that they had encountered eight such cases in their experience, six cases in angiograms that disclosed nothing abnormal and two cases in association with cerebral arteriovenous malformations (AVMs). They noted that these sinuses can have different posterior openings, i.e., into the straight sinus, the confluens, or the transverse sinus. The anterior and diencephalic afferents to the basal vein constitute the usual veins draining into the sinus; however, an infratemporal vein may also join the sinus.

Kaplan et al.[32], in their study of venous channels within the intracranial dural partitions, noted that, in many instances, natural blood injections were sufficient to demonstrate the course, size, and connections of the venous channels, particularly in the tentorium cerebelli and falx cerebri.

They also noted that because three-fourths of the circumference of the tentorium contained venous channels, venous pathways within the tentorium cerebelli may be frequently observed connecting the major sinuses in this region, in patients of all age groups.

They also described a cavernous network of veins within the dorsal aspect of the tentorium cerebelli in infants that anastomosed with the larger channels in the tentorium and was maximal near the caudal straight sinus and adjacent tentorium; during early to midchildhood, these small vessels apparently dwindle, whereas larger venous channels within the tentorium persist.

In addition, the tentorial sinuses may serve as important venous channels that communicate the posterior dural sinuses with the cavernous sinus. The straight sinus communicates with the cavernous sinus by the tentorial sinus(straight sinus > tentorial sinus > petrosal sinus > cavernous sinus).

The transverse and sigmoid sinuses may receive direct drainage from the superficial sylvian vein by way of the tentorial sinus; thus, they may communicate with the cavernous sinus[33]. The basal vein may also drain into the tentorial sinus[34].

Tentorial sinuses in congenital malformation

The deep venous system is abnormal in certain congenital malformations of the brain. Yokota et al.[35] and Osaka et al.[35] reported that in holoprosencephaly, diencephalic cysts, and midline porencephalies, the galenic system is deficient. In such cases, the basal ganglia are drained by peculiar veins that course laterally and drain into the transverse sinus through the tentorial sinus[35,36].

They considered these to be diencephalic veins that retained their embryological pattern of drainage (early in development, before the development of the basal vein, the diencephalic veins drain into the tentorial sinus). Yokota et al.and Osaka et al. also reported that this type of deficiency of the deep venous system is absent in other congenital midline anomalies, such as agenesis of the corpus callosum, and thus serves to differentiate between the two[35,36].

Radiological demonstration of Tentorial sinuses

Several angiographic studies described the presence of venous sinuses in the tentorium[37]. However, when compared with the high incidence of venous sinuses in the tentorium as described in anatomic studies, the number of radiological studies that describe the presence of these sinuses is disproportionately low.

This apparent discrepancy may be attributable to several reasons

1) the lack of awareness of the presence of these venous sinuses
2) because dural venous sinuses fill from many sources, the venous sinuses (in venous phase images obtained from any single arterial injection) may not be opacified because of inflow of unopacified blood from other vascular territories.

However, recent advances in magnetic resonance venography and computed tomographic venography may allow a more reliable way of studying the dural venous sinuses than conventional angiography.

Mattle et al.[38] reported that venous sinuses are better visualized on magnetic resonance venograms. Advances in magnetic resonance venography might allow accurate demonstration of venous sinuses within the tentorium.

Other noninvasive techniques such as contrast-enhanced transcranial color-coded real-time sonography may be useful to evaluate these dural venous sinuses.

Suzuki et al in his study of three-dimensional computed tomography angiography of the galenic system for the occipital transtentorial approach,mentioned about various types of tentorial venous sinus.

Miabi et al.[39] studied the lateral tentorial sinus with routine contrast enhanced MR images in 55 adult patients and reported that it was detected in 104 of 110 lobes. The lateral tentorial sinus in each lobe was classified as type I (candelabra) in 30 (28.8%), type II (independent veins) in 22 (21.1%), and type III (venous lakes) in 37 (35.5%); in 15 (14.4%) of the lobes, the lateral tentorial sinus was indeterminate. Lateral tentorial sinus branches were inconsistently detected, with the exception of the vein of Labbé. Five of eight branches were seen in approximately half of the cases.

The vein of Labbé was identified in 94 (85.4%) lobes. Among these, 53 (56.4%) were draining into the lateral tentorial sinus and 22 (23.4%) into the transverse sinus; in 19 (20.2%) cases, the terminal portion was not visualized. The right transverse sinus was dominant in 19 (34.5%) patients and the left in 18 (32.7%); codomination was present in 18 (32.7%) cases. At least one arachnoid granulation was seen in the transverse sinus in 27 (49.1%) patients.

Mapping the temporal venous anatomy is crucial for surgeons considering lateral skull base explorations. During such operations, surgeons often manipulate the lateral tentorial sinus and its branches while lifting up the temporal lobe to achieve adequate exposure and working space. Surgeons make the best effort to preserve the bridging veins to avoid a venous infarct. They considered that conventional contrast-enhanced MR imaging can be used as a tool to evaluate the temporal venous anatomy.

RESULTS

Variations of tentorial venous sinus in cadaver cerebellar tentoria were examined in 100 autopsy. Venous sinuses were present in tentorium in 91(91%) cadavers and absent in 9 cadavers. There were 145 tentorial venous sinuses in 91 cadavers. Of these sinuses, 81 (55.9%) occurred on left side, 64 (44.1%) occurred on right side.

An imaginary line drawn horizontally at the junction of the superior petrosal sinus and transverse sinus was used to divide the tentorium arbitrarily into anterior and posterior portions. And again the tentorium was arbitrarily divide into medial one-third, middle one-third, lateral one-third on corresponding to the transverse sinus.

Only one tentorial venous sinus was encountered in the anterior portion of tentorium cerebelli. The sinuses were bilateral in 33 cadavers and more than 2 sinuses encountered in 16 cadavers.

The tentorial sinuses were classified into four groups, depending on their location, size, configuration, and pattern of drainage.

Group1: venous sinuses in medial one-third of tentorium cerebelli

Type a: sinuses draining into straight sinus

Type b: sinuses draining into torcular sinus

Type c: sinuses draining into medial one-third of transverse sinus

Group2: venous sinuses in middle one-third of tentorium cerebelli

Group3: venous sinuses in lateral one-third of tentorium cerebelli

Group 4: venous ring pattern

Group1: Venous sinuses in medial one-third of tentorium cerebelli

Group 1 sinuses constituted 47.6% (69 sinuses) of the total tentorial venous sinuses in this study. Among these sinuses 53.6% (37 sinuses) were on the left side of the tentorium cerebelli and 46.4% (32 sinuses) were on the right side of the tentorium cerebelli. The tentorial sinuses of Group 1 were frequently present as a large sinus with occasional branching when compare with other groups.

According to their draining veins they were separated into three subtypes. In Type a, the sinus courses transversely to drain into the straight sinus. In Type b, the sinus courses posteromedially to drain into the torcular sinus. In Type c, the sinus drains into the medial one-third of transverse sinus.

In this study, 22 (32%) sinuses were type a, 40 (58%) sinuses were type b, 7 (10%) sinuses were type c, among the Group 1 sinuses. Of these 69 sinuses, 6 sinuses which were longer in size occupying a small portion of medial part of middle one-third of tentorium cerebelli along with its course in entire medial one-third of tentorium cerebelli.

Most often Group1 sinuses were drained by the terminal portions of the cerebellar hemispheric or vermian veins.

Group2: Venous sinuses in middle one-third of tentorium cerebelli

Group 2 sinuses constituted 6.9%(10 sinuses) of the total. Among these sinuses, two sinuses were on the right side and eight sinuses were on the left side . All of these sinuses were smaller in size. No branching pattern was observed in Group 2 sinuses. All of these sinuses were observed to drain into the middle one-third of the transverse sinus.

Group3: Venous sinuses in lateral one-third of tentorium cerebelli

Group3 sinuses constituted 40% (58 sinuses) of the 145 sinuses in this study. Among these sinuses 55.2% (32 sinuses) were on the left side and 44.8% (26 sinuses) were on the right side. The tentorial sinuses of Group 3 were drained into lateral one-third of transverse sinus or to the junction of the transverse sinus and superior petrosal sinus.

When compare with Group 1 sinuses these sinuses were smaller and occasionally showing branching pattern like that of the above mentioned one. Most often these siuses were drained by the the terminal portions of the cerebral hemispheric veins, frequently by vein of labbe.

Group 4: Venous ring pattern

In six cadavers, there was a large tentorial venous sinus connecting the torcular sinus to the lateral one-third of transverse sinus or to the junction of transverse sinus and superior petrosal sinus, thereby forming a "venous ring". These venous ring was occupying the entire posterior portion of tentorium cerebelli. This venous ring was bilateral in two cadavers and unilateral in four cadavers. Among these 8 sinuses(5.5% of total sinuses), four sinuses(50%) were on the right side of the tentorium cerebelli and four sinuses(50%) were on the left side of the tentorium cerebelli.

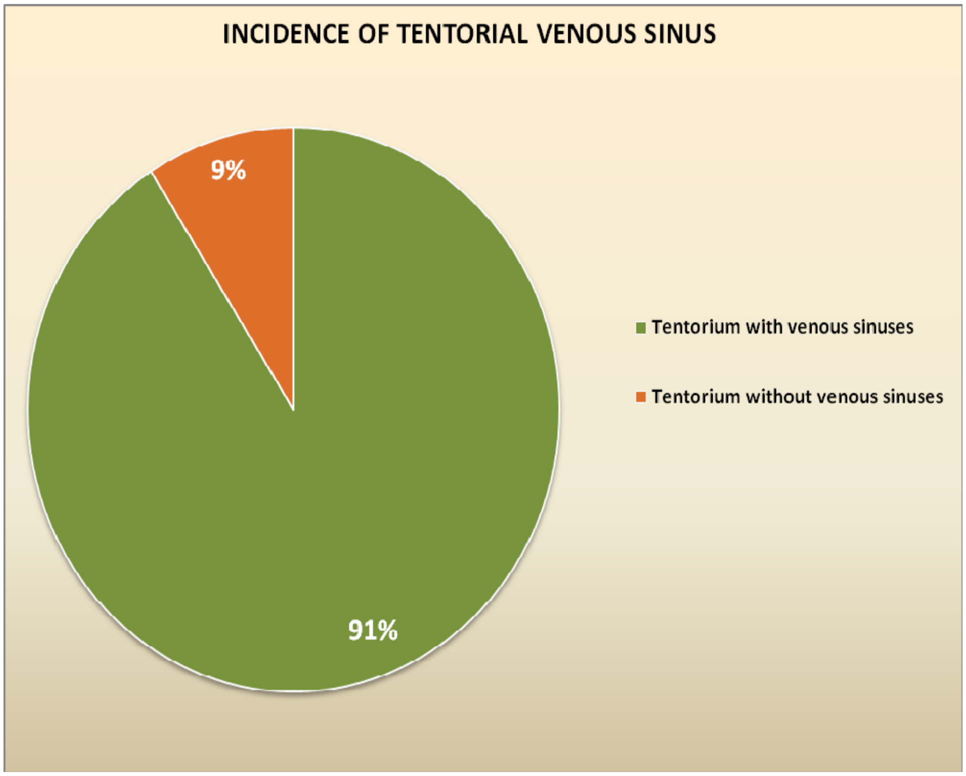
Incidence of tentorial venous sinus

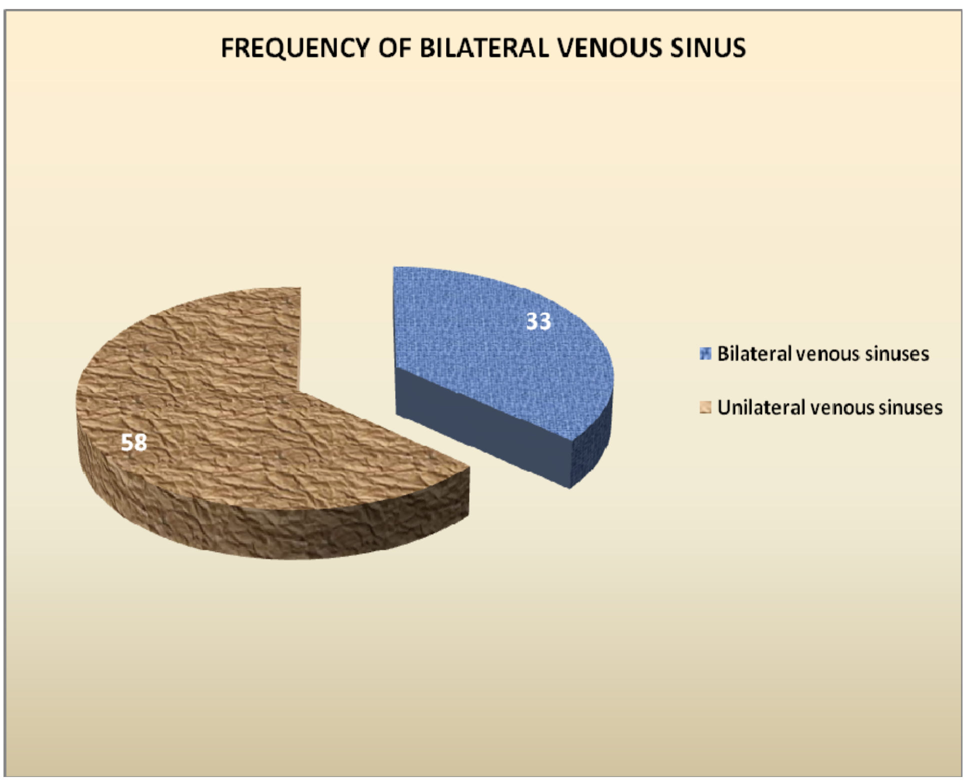
Total no.of cadavers studied	Tentorium with venous sinuses
100	91

Incidence of tentorial venous sinus is 91%.

Frequency of bilateral venous sinuses

Total no.of cadavers with tentorial venous sinuses	Bilateral venous sinuses	Unilateral venous sinuses
91	33 (36.3%)	58 (63.7%)


INCIDENCE OF TENTORIAL VENOUS SINUS
9%
91%
Tentorium with venous sinuses
Tentorium without venous sinuses


FREQUENCY OF BILATERAL VENOUS SINUS
33
58
Bilateral venous sinuses
Unilateral venous sinuses

Frequency of venous sinuses in left and right side of tentorium

Total no.of venous sinuses	Left side	Right side
145	81(55.9%)	64(44.1%)

Frequency of venous sinuses by location in tentorium

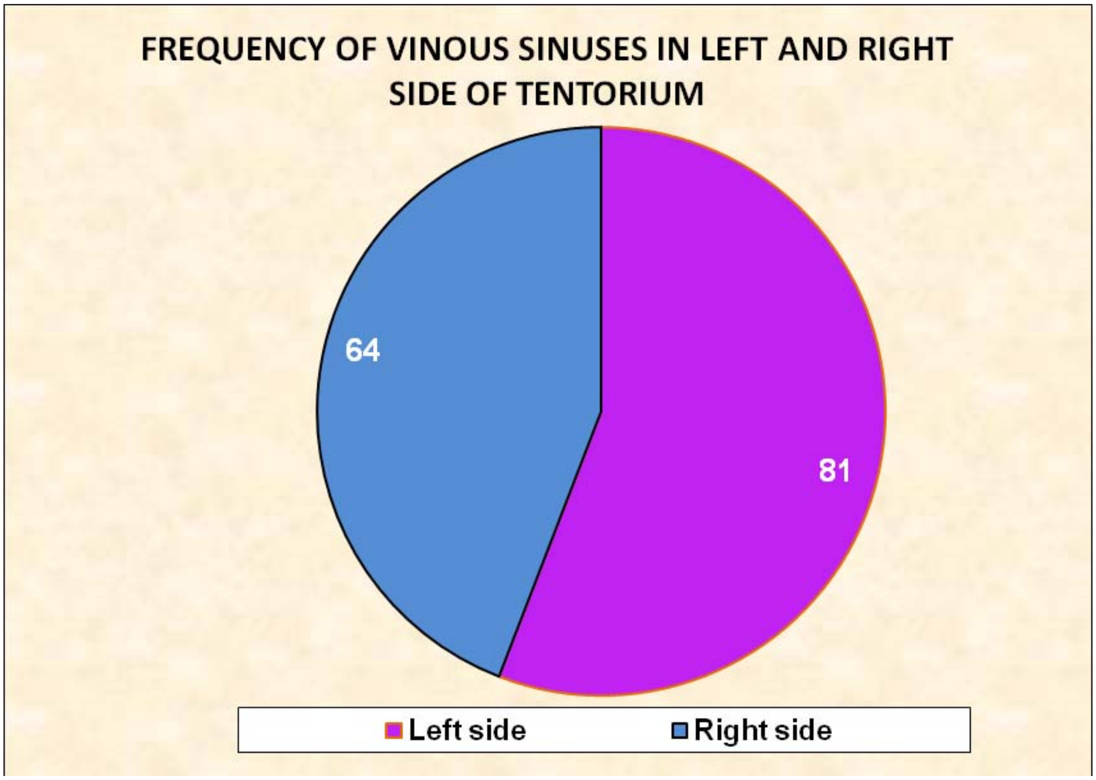
Medial one-third of tentorium	Middle one-third of tentorium	Lateral one-third of tentorium
69	10	58

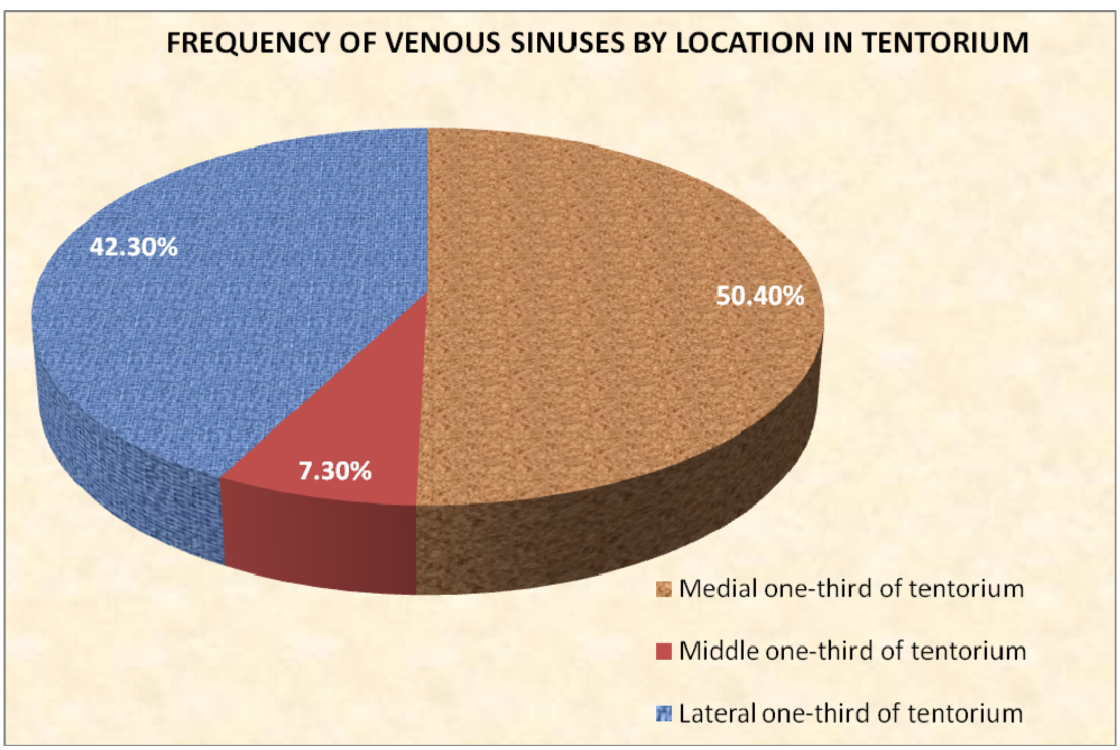
(Venous ring pattern excluded)

Frequency of tentorial venous sinuses by location in percentage

Medial one-third of tentorium	Middle one-third of tentorium	Lateral one-third of tentorium
50.4%	7.3%	42.3%

(Venous ring pattern excluded)


FREQUENCY OF VINOUS SINUSES IN LEFT AND RIGHT SIDE OF TENTORIUM
64
81
Left side
Right side

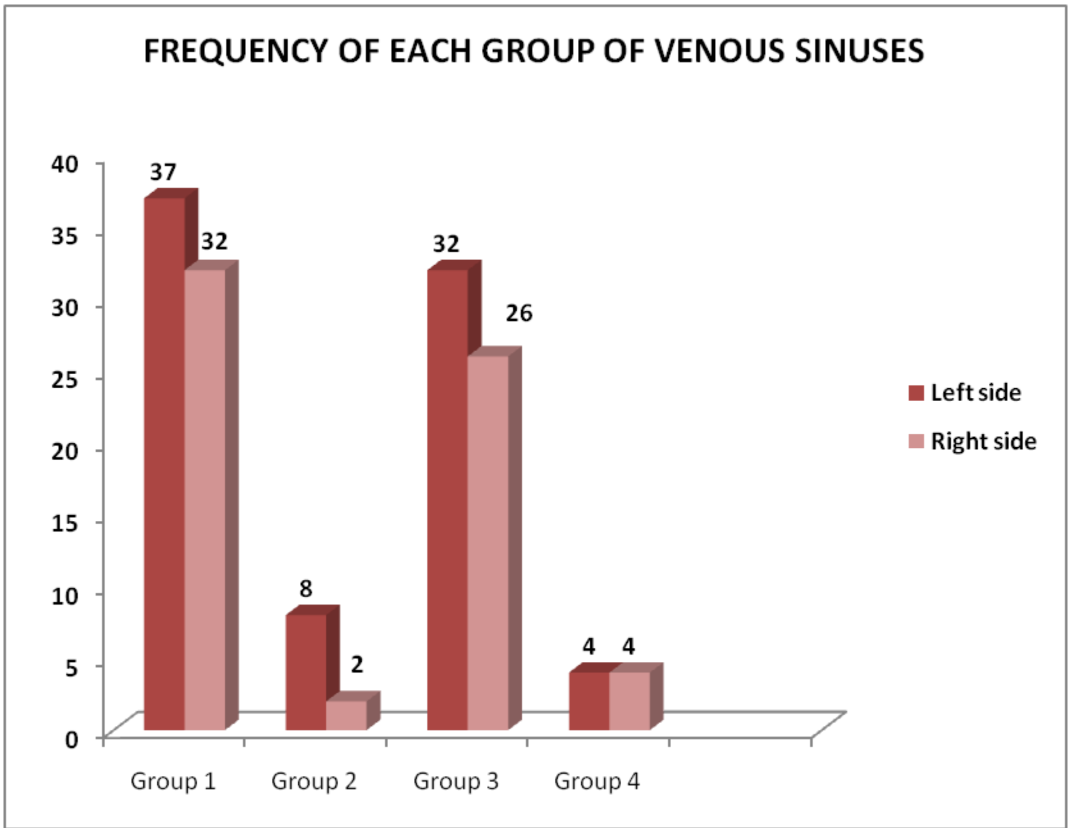

FREQUENCY OF VENOUS SINUSES BY LOCATION IN TENTORIUM
42.30%
50.40%
7.30%
Medial one-third of tentorium
Middle one-third of tentorium
Lateral one-third of tentorium

Frequency of each group of venous sinuses

Classification	Left side	Right side	total
Group 1	37	32	69
Group 2	08	02	10
Group 3	32	26	58
Group 4	04	04	08
Total	81	64	145

Frequency of each group of tentorial venous sinuses by percentage

Classification	No. of venous sinuses	Percentage
Group 1	69	47.6%
Group 2	10	6.9%
Group 3	58	40%
Group 4	08	5.5%


FREQUENCY OF EACH GROUP OF VENOUS SINUSES
40
35
30
25
20
15
10
5
0
37
32
8
2
32
26
4
4
Left side
Right side
Group 1
Group 2
Group 3
Group 4

Frequency of venous sinuses by drainage pattern

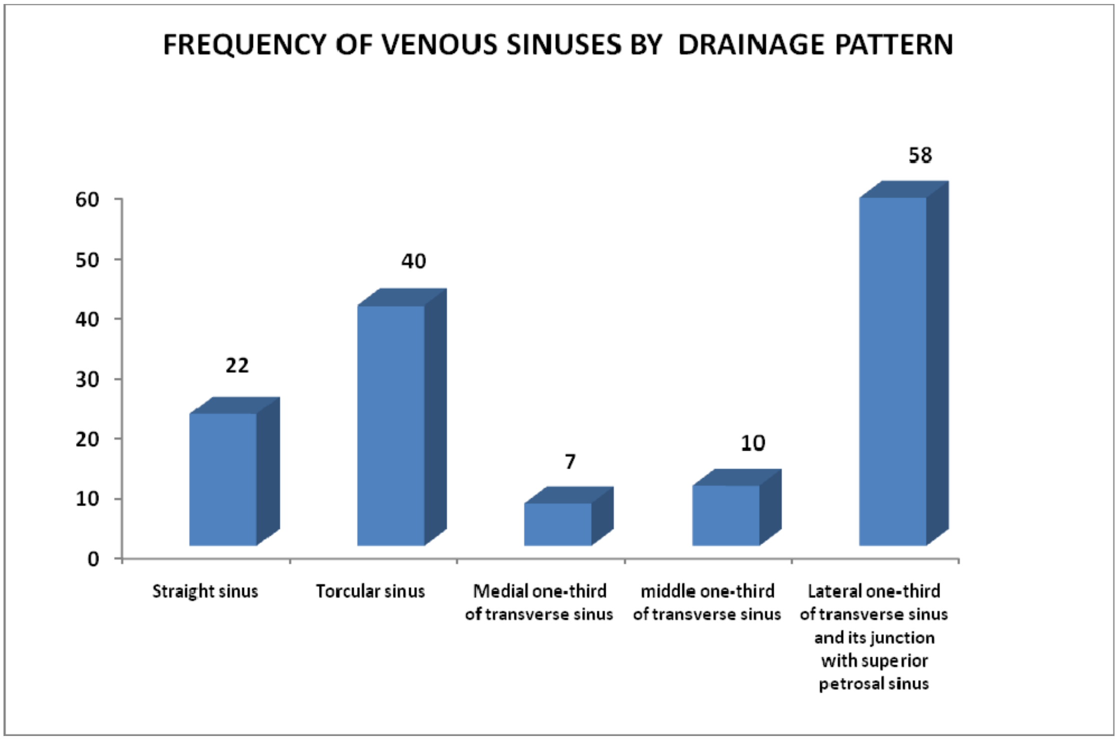
Draining sinuses	Total no.of tentorial sinuses
Straight sinus	22
Torcular sinus	40
Medial one-third of transverse sinus	07
middle one-third of transverse sinus	10
Lateral one-third of transverse sinus and its junction with superior petrosal sinus	58

(Venous ring pattern excluded)

Frequency of venous sinuses by drainage pattern in percentage

Draining sinuses	Percentage
Straight sinus	16.1%
Torcular sinus	29.2%
Medial one-third of transverse sinus	5.1%
middle one-third of transverse sinus	7.3%
Lateral one-third of transverse sinus and its junction with superior petrosal sinus	42.3%

(Venous ring pattern excluded)


FREQUENCY OF VENOUS SINUSES BY DRAINAGE PATTERN
60
50
40
30
20
10
0
22
40
7
10
58
Straight sinus
Torcular sinus
Medial one-third of transverse sinus
middle one-third of transverse sinus
Lateral one-third of transverse sinus and its junction with superior petrosal sinus

DISCUSSION

Traditionally, anatomists, pathologists, and clinicians have devoted their attention to the major intracranial venous sinuses. Following in their footsteps, neurosurgeons have become knowledgeable regarding the size, course, and tributaries of the major venous sinuses. Knowledge of the variations of the dural venous sinuses is important to distinguish normal variations from pathological processes .

However, until recently, venous sinuses in the tentorium cerebelli received scant attention in the text book of neuroanatomy, neurosurgery and even in the literature.

Gibbs and Gibbs, in their study on the torcular and lateral sinuses, seem to have been the first to describe tentorial sinuses. They observed two sinuses in the tentorium which received blood from the superior cerebellar veins and emptied into the transverse sinus near the straight sinus. After their report, the tentorial sinuses were noted in studies of the dural sinuses near the torcular.

Browder et al. studied the presence of venous channels in the tentorium by injecting a vinylite-acetone mixture and then producing corrosion casts. They observed that venous channels are extremely common in the tentorium.

They also noted that, in most instances, the least vascular part of the tentorium is its middle portion. They suggested that in addition to phlebographic studies, the presence and the course of these venous channels could be established intraoperatively by jugular compression.

In his study of the anatomic variations of the venous sinuses in the region of the torcular herophili, Bisaria[40] noted the presence of venous sinuses within the tentorium cerebelli.

Saxena et al.[41] reported that in 10% of healthy patients, the straight sinus communicates with the lateral sinus by means of tentorial veins.

Oka et al.[42] reported that each half of the tentorium had two consistent, but frequently asymmetrical, sinuses, the medial and lateral tentorial sinuses. The medial sinuses received the superficial veins of the cerebellum and drained into the junction of the straight and transverse sinuses, and the lateral tentorial sinuses received the veins of the lateral surface of the temporal and occipital lobes and drained into the transverse sinuses.

Variations of the tentorial sinus in cerebellar tentoria of 13 cadavers were examined under a surgical microscope by Matsushima et al and classified the tentorial sinuses into four groups: Group I, in which the sinus receives venous blood from the cerebral hemisphere; Group II, in which the sinus drains the cerebellum; Group III, in which the sinus originates in the tentorium itself: and Group IV, in which the sinus originates from a vein bridging to the tentorial free edge. The tentorial sinuses of Groups I and II were frequently located in the posterior portion of the tentorium.

The sinuses of Group I were short and most frequently present in the lateral portion of the tentorium. The tentorial sinuses of Group II, which were usually large and drained into the dural sinuses near the torcular, were separated into five subtypes according to the draining veins and direction of termination.

The tentorial sinuses of Groups III and IV were located near the tentorial free edge or the straight sinus.

In their study, venous sinuses were present in all of the 13 tentoria studied; Group II sinuses were the most frequent, with Group I being the next most frequent. Group I sinuses were predominantly located in lateral one-third of tentorium cerebelli, but the Group II sinuses were less frequently located in the lateral one-third of the tentorium cerebelli than in the middle and medial one-thirds.

Koperna et al.[43] studied the termination of Labbé's vein and observed that in 73% of the cases, Labbé's vein reaches the transverse sinus through a tentorial sinus. Information about the termination of the inferior anastomotic vein of Labbé is of crucial importance in the subtemporal neurosurgical approach and its modifications. By dissecting the vein of

Labbé out of its dural bed and shifting its fixation point, microsurgical access is facilitated considerably.

Duval et al. studied 23 cadavers using a retrograde veinous injection of a mixture of Rhodopas and lead tetroxide and observed that the tentorial sinus was present in more than half of the cases and considered this sinus as a true sinus, principally draining the superior and inferior hemispheric veins of the cerebellum. He also noted the tentorial sinus traversed the posterior portion of the tentorium cerebelli and opened into the lateral or straight sinus.

Muthukumar et al.[1] studied cerebellar tentoria in 80 cadavers and reported that the tentorium cerebelli was revealed to contain sinuses in 86% of the cadavers. He classified the sinuses into the following three types:

Type I sinuses constituted 25% of the total and were most often located in the medial one-third of the tentorium. They were larger than the other types, frequently occurring with a branching "stag-horn" configuration and a tendency to drain into the straight sinus, the torcular herophili, and the medial one-third of the transverse sinus.

Type II sinuses constituted 25% of the total and were most often located in the lateral one-third of the tentorium. They were smaller than the other types, and tended to drain into the duction of the transverse sinus and superior petrosal sinus and into the lateral one-third of the transverse sinus.

Type III sinuses constituted 50% of the total and were located in the medial one-third of the tentorium. Their size ranged from small to medium. Unlike Type I sinuses, no branching pattern was observed. These sinuses tended to drain into the straight sinus, the torcular herophili, and the medial one-third of the transverse sinus.

He considered, the medial one-third of the tentorium was the most vascular part. No venous sinus was observed in the anterior part of the tentorium in his study. He observed the venous ring pattern in three cadavers.

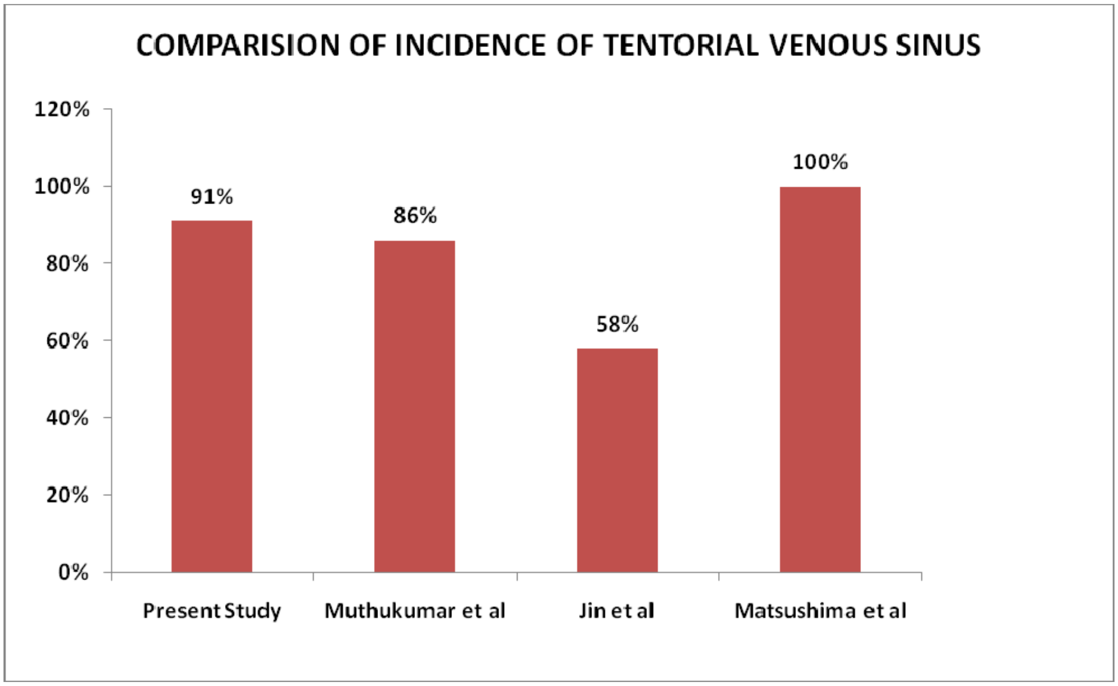
Jin et al[44] in his study of the normal variation of tentorial sinuses draining into the straight sinus in 50 cadavers reported that tentorial venous sinuses present in 29(58%) cadavers and absent in 21(42%) cadavers.

He divided the draining site of the tentorial sinuses at the straight sinus into 3 zones : Zone 1, anterior one third of the straight sinus, into which 15 out of 63 tentorial sinuses were found to be drained, zone 2 which is the most prevalent site, middle one third of the straight sinus draining 27 out of 63 tentorial sinuses and zone 3, posterior one third of the straight sinus draining 21 out of 63 tentorial sinuses.

In this present study, tentorial venous sinus was present in 91 (91%) cadavers and absent in 9 cadavers. It is bilateral in 33 cadavers and more than two sinuses were present in 16 cadavers. The incidence of tentorial venous sinus is more when compare with the studies of Muthukumar et al (86%) Duval et al and Jin et al (58%) and less with the studies of Matsushima et al (100%).

Comparison of Incidence of Tentorial venous Sinus

Present study	**Muthukumar et al**	**Jin et al**	**Matsushima et al**
91%	86%	58%	100%

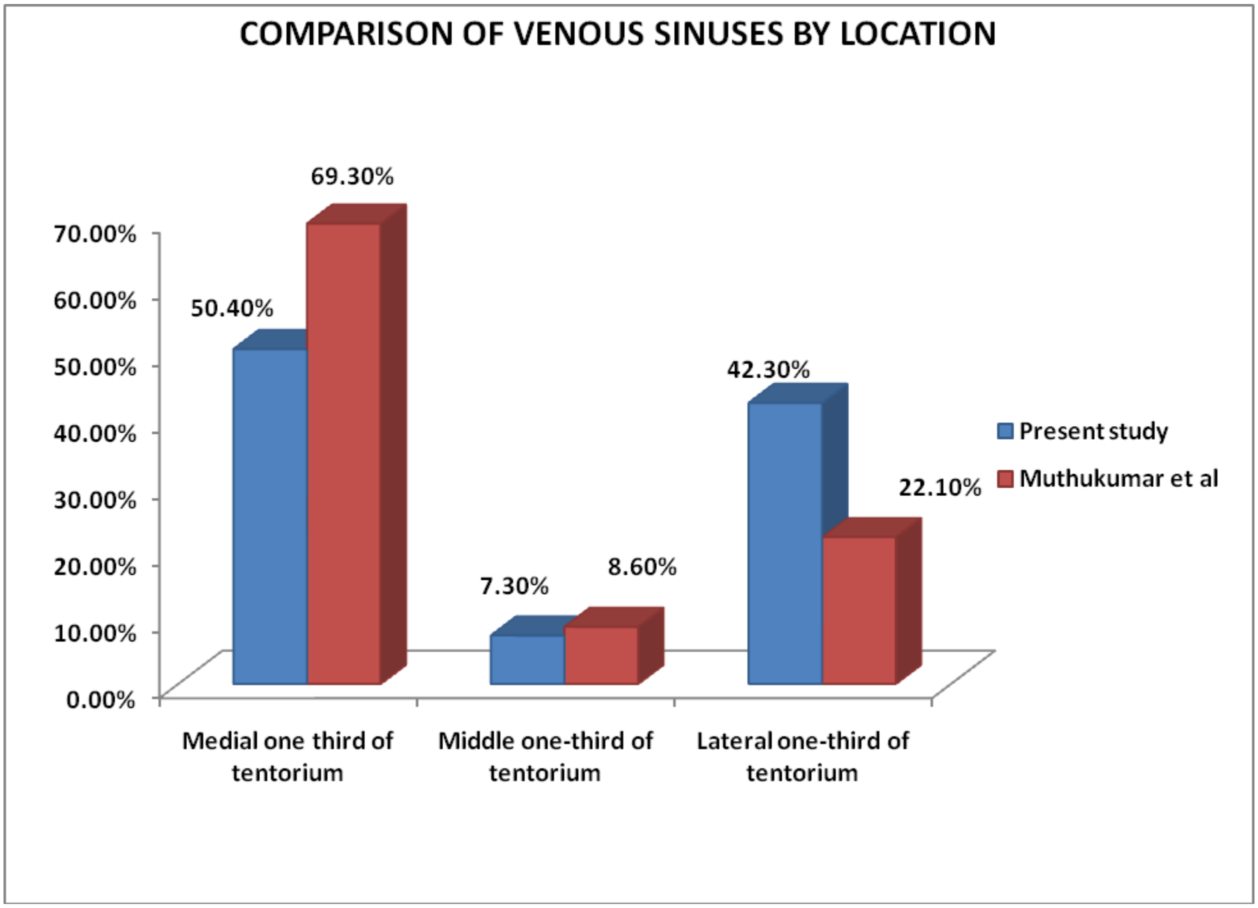

COMPARISION OF INCIDENCE OF TENTORIAL VENOUS SINUS
120%
100%
80%
60%
40%
20%
0%
91%
86%
58%
100%
Present Study
Muthukumar et al
Jin et al
Matsushima et al

The incidence of tentorial venous sinuses in left side (55.9%) is more than the right side(44.1%).

In this study, 50.4% of tentorial venous sinuses are located in medial one-third of tentorium cerebelli, 7.3% in middle one-third of tentorium cerebelli,42.3% in lateral one-third of tentorium cerebelli. But in the study of Muthukumar 69.3% of tentorial venous sinuses are located in medial one-third of tentorium cerebelli, 8.6% in middle one-third of tentorium cerebelli, 22.1% in lateral one-third of tentorium.

Comparison of Venous sinuses by location

Studies	**Medial one –third of tentorium**	**Middle one-third of tentorium**	**Lateral one-third of tentorium**
Present study	50.4%	7.3%	42.3%
Muthukumar et al	69.3%	8.6%	22.1%


COMPARISON OF VENOUS SINUSES BY LOCATION
69.30%
50.40%
42.30%
22.10%
7.30%
8.60%
70.00%
60.00%
50.00%
40.00%
30.00%
20.00%
10.00%
0.00%
Medial one third of tentorium
Middle one-third of tentorium
Lateral one-third of tentorium
Present study
Muthukumar et al

Miabi et al in his study of lateral tentorial sinus with routine contrast enhanced MR images in 55 adult patients, reported that it was detected in 104 of 110 lobes.

The incidence of tentorial venous sinuses located in lateral one-third of tentorium cerebelli in this study is almost twice that of Muthukumar et al study.

In this study, the middle one-third of tentorium cerebelli is found to be least vascular.

CONCLUSION

1. The incidence of tentorial venous sinus in this cadaveric study is 91%.
2. Depending on their location,size,configuration, and pattern of drainage, the tentorial venous sinuses are classified into four groups
3. Group1: venous sinuses in medial one-third of tentorium cerebelli

   Type a: sinuses draining into straight sinus

   Type b: sinuses draining into torcular sinus

   Type c: sinuses draining into medial one-third of transverse sinus

   Group2: venous sinuses in middle one-third of tentorium cerebelli

   Group3: venous sinuses in lateral one-third of tentorium cerebelli

   Group 4: venous ring pattern
4. 50.4% of tentorial venous sinuses are located in medial one-third of tentorium cerebelli, 7.3% in middle one-third of tentorium

cerebelli, 42.3% in lateral one-third of tentorium cerebelli. (venous ring pattern is excluded)

5. Middle one-third of tentorium cerebelli is the least vascular portion.
6. These findings will be useful for procedures that require sectioning of the tentorium.
7. These sinuses serve as important collateral channels when the straight sinus or torcular herophili is occluded by pathological processes.
8. They also play an important role in several vascular and congenital malformations of the brain.

MASTER CHART

S.no	Name	Age	sex	No. of sinuses			Group 1			Group 2	Group 3	Group 4
				left	Right	total	Type a	Type b	Type c			
1	Kumarasamy	48	M	1	-	1	-	1	-	-	-	-
2	Maheswari	34	F	1	-	1	-	-	-	-	1	-
3	Iyyapan	52	M	1	-	1	-	-	-	1	-	-
4	Balaji	21	M	2	1	3	-	2	-	-	1	-
5	Sekar	51	M	1	1	2	2					
6	Anbu	37	M	-	1	1	-	-	1	-	-	-
7	Raju	65	M	1	1	2	-	2	-	-	-	-
8	Lakshmi	45	F	1	1	2	-	-	-	-	2	-
9	Aadhi nayagam	32	M	1	-	1	-	-	-	-	1	-
10	Deivaniammal	55	F	-	1	1	-	-	-	-	1	-
11	Karthik	25	M	-	1	1	-	-	1	-	-	-
12	Karruppu	55	M	-	-	-	-	-	-	-	-	-
13	Murugan	63	M	-	1	1	-	1	-	-	-	-
14	Krishnaveni	29	F	2	2	4	-	2	-	-	2	-
15	Rajaram	38	M	1	-	1	-	-	-	-	-	1
16	Jawahar	45	M	1	-	1	-	-	-	1	-	-
17	Thenmozhi	27	F	1	2	3	1	-	-	-	2	-
18	Rani	36	F	1	1	2	-	-	-	-	2	-

19	Vennila	32	F	1	-	1	-	1	-	-	-	-
20	Devendhiran	44	M	1	1	2	-	2	-	-	-	-
21	Petchiammal	65	F	-	1	1	-	-	-	-	1	-
22	Murugeswari	54	F	2	2	4	-	2	-	-	2	-
23	Kottai muthu	60	M	-	1	1	-	1	-	-	-	-
24	Ramasubbu	60	M	-	-	-	-	-	-	-	-	-
25	Kuruvammal	67	F	2	1	3	2	-	-	-	1	-
26	Pandi	40	M	1	-	1	-	-	-	-	1	-
27	Eswari	40	F	1	1	2	1	1	-	-	-	-
28	Selvarajan	52	M	1	-	1	-	-	-	1	-	-
29	Sagundala	55	F	1	-	1	-	-	-	-	-	1
30	Pattathu rani	25	F	1	-	1	-	1	-	-	-	-
31	Murugeswari	21	F	1	-	1	-	-	-	-	1	-
32	Palani	36	M	-	-	-	-	-	-	-	-	-
33	Meenatchi	33	F	2	2	4	2	-	-	-	2	-
34	Murugananthan	40	M	2	1	3	2	-	-	-	1	-
35	Saravanan	54	M	-	1	1	-	-	-	-	-	1
36	Gejalakshmi	61	F	1	-	1	-	-	-	1	-	-
37	Annammal	29	F	1	1	2	-	-	-	2	-	-
38	Magesh	36	M	-	-	-	-	-	-	-	-	-
39	Pandiyan	56	M	1	2	3	-	1	-	-	2	-
40	Moorthi	61	M	-	-	-	-	-	-	-	-	-
41	Chandran	47	M	1	1	2	1	-	-	-	1	-
42	Anjalai	60	F	-	1	1	-	-	-	-	1	-

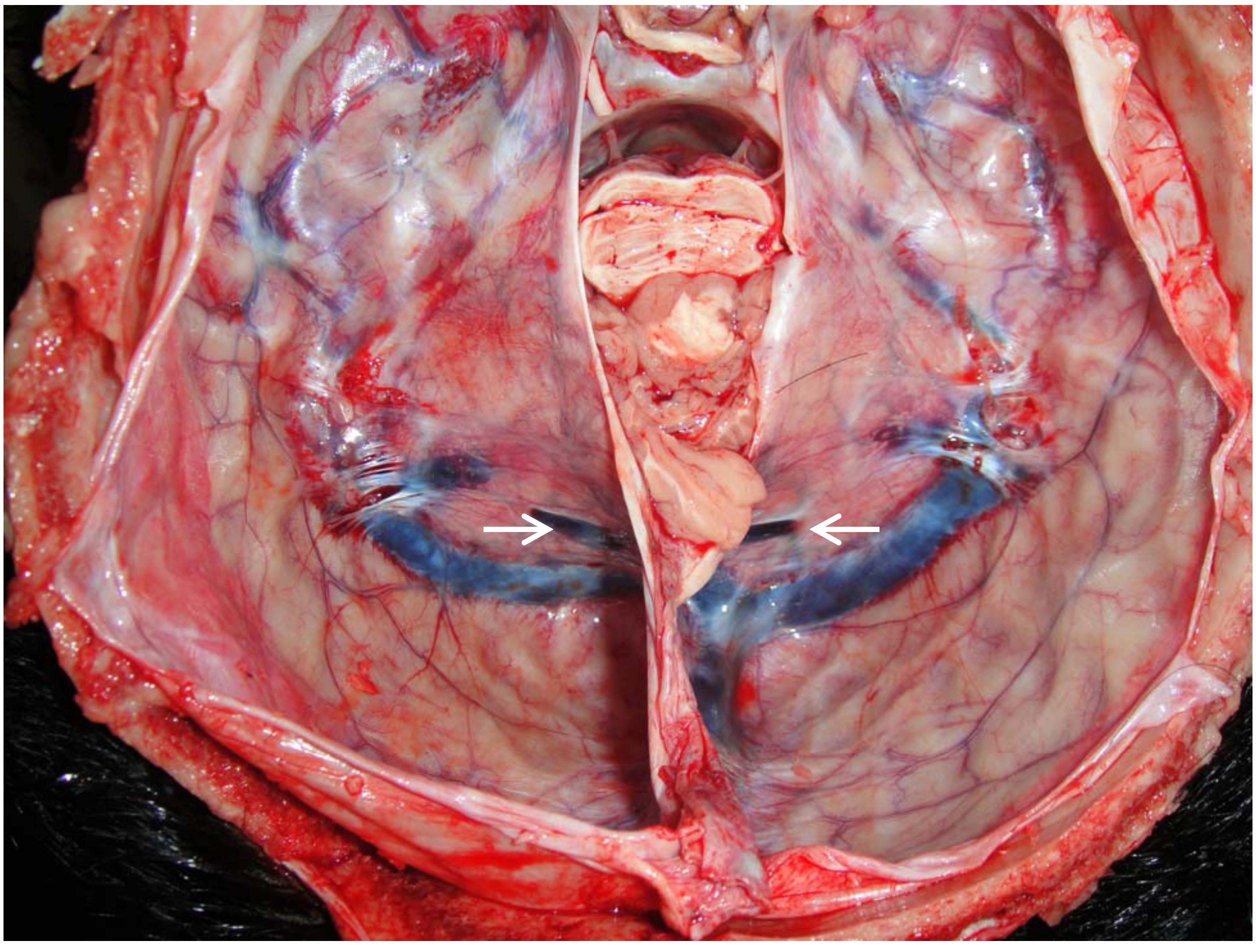
43	Papa	58	F	1	-	1	-	-	1	-	-	-
44	Rajagopal	53	M	1	1	2	1	1	-	-	-	-
45	Palanivel	46	M	2	1	3	-	2	-	-	1	-
46	Gurusamy	66	M	1	-	1	-	-	-	-	1	-
47	Ibrahim	30	M	1	-	1	-	1	-	-	-	-
48	Kumaresan	59	M	1	1	2	1	-	-	-	1	-
49	Latha	36	F	-	1	1	-	-	-	-	1	-
50	Kuppammal	65	F	1	-	1	-	1	-	-	-	-
51	Vellayan	68	M	2	2	4	-	2	-	-	2	-
52	Raman	68	M	2	1	3	-	1	-	-	2	-
53	Ganesan	42	M	-	-	-	-	-	-	-	-	-
54	Uma	38	F	1	1	2	-	1	-	-	1	-
55	Loganayaki	65	F	-	1	1	-	-	-	-	1	-
56	Babu	41	M	1	-	1	-	-	-	-	1	-
57	Sagayam	48	M	1	1	2	-	-	-	2	-	-
58	Rajalakshmi	30	F	1	-	1	1	-	-	-	-	-
59	Indirani	47	F	1	-	1	-	-	-	1	-	-
60	Akilandam	60	F	1	-	1	-	-	1	-	-	-
61	Perumol	65	M	1	2	3	2	-	-	-	1	-
62	Suseela	22	F	-	1	1	-	1	-	-	-	-
63	Balakrishnan	70	M	1	-	1	-	-	-	-	1	-
64	Chinnasamy	46	M	1	1	2	-	2	-	-	-	-
65	Mumthajbanu	45	F	-	1	1	-	1	-	-	-	-
66	Kalidoss	52	M	2	2	4	2	-	-	-	2	-

67	Ahamed	21	M	-	-	-	-	-	-	-	-	-
68	Jeysankar	54	M	1	-	1	-	-	-	-	1	-
69	Rengan	45	M	2	1	3	-	1	-	-	2	-
70	Vellimalai	55	M	1	-	1	-	1	-	-	-	-
71	Pounthai	30	F	-	1	1	-	-	-	-	1	-
72	Nagammal	49	F	-	1	1	-	1	-	-	-	-
73	Prabakaran	57	M	-	-	-	-	-	-	-	-	-
74	Anthonisamy	62	M	1	1	2	-	-	-	-	-	2
75	Isakimuthu	51	M	1	1	2	-	-	-	-	2	-
76	Valarmathi	45	F	1	-	1	1	-	-	-	-	-
77	Chinnaponnu	64	F	1	-	1	-	1	-	-	-	-
78	Vignesh	27	M	1	-	1	-	-	1	-	-	-
79	Muniyandi	48	M	-	1	1	-	-	-	-	1	-
80	Kannan	53	M	1	-	1	-	-	-	1	-	-
81	Kaja	39	M	-	1	1	-	-	-	-	1	-
82	Vijaya	44	F	1	-	1	-	1	-	-	-	-
83	Selvi	33	F	1	2	3	-	1	-	-	2	-
84	Dharmar	57	M	1	-	1	-	-	-	-	1	-
85	Egambaram	66	M	-	-	-	-	-	-	-	-	-
86	Elumalai	42	M	1	-	1	1	-	-	-	-	-
87	Paraman	60	M	1	-	1	-	-	-	-	1	-
88	Vellayammal	38	F	1	1	2	-	-	-	-	-	2
89	Jeevananthan	55	M	1	-	1	-	-	1	-	-	-
90	Maheswari	23	F	-	1	1	-	-	-	-	1	-

91	Rajamani	25	F	1	-	1	-	-	-	-	1	-
92	Kalimuthu	44	M	1	1	2	-	1	-	-	1	-
93	Rohini devi	21	F	2	1	3	-	2	-	-	1	-
94	Vanathi	32	F	-	1	1	-	-	-	-	1	-
95	Marimuthu	30	M	-	1	1	1	-	-	-	-	-
96	Chitra	42	F	-	1	1	-	-	-	-	-	1
97	Dhanasekaran	53	M	1	-	1	-	-	1	-	-	-
98	Durairaj	64	M	-	1	1	-	1	-	-	-	-
99	Murugan	25	M	1	-	1	-	-	-	-	1	-
100	Rajammal	52	F	-	1	1	1	-	-	-	-	-

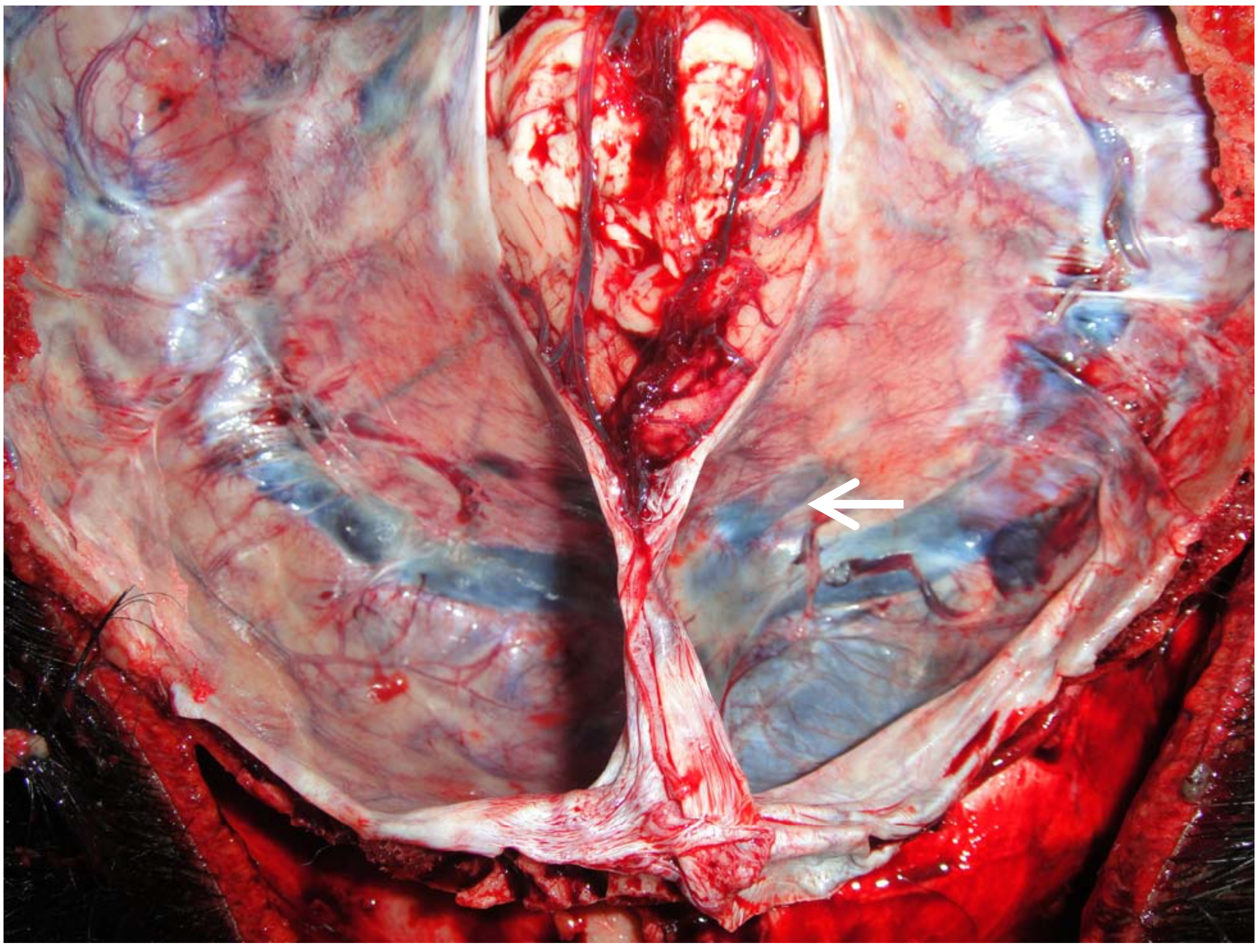
GROUP1: VENOUS SINUSES IN MEDIAL ONE-THIRD OF TENTORIUM CEREBELLI

Type a: Sinuses draining into straight sinus



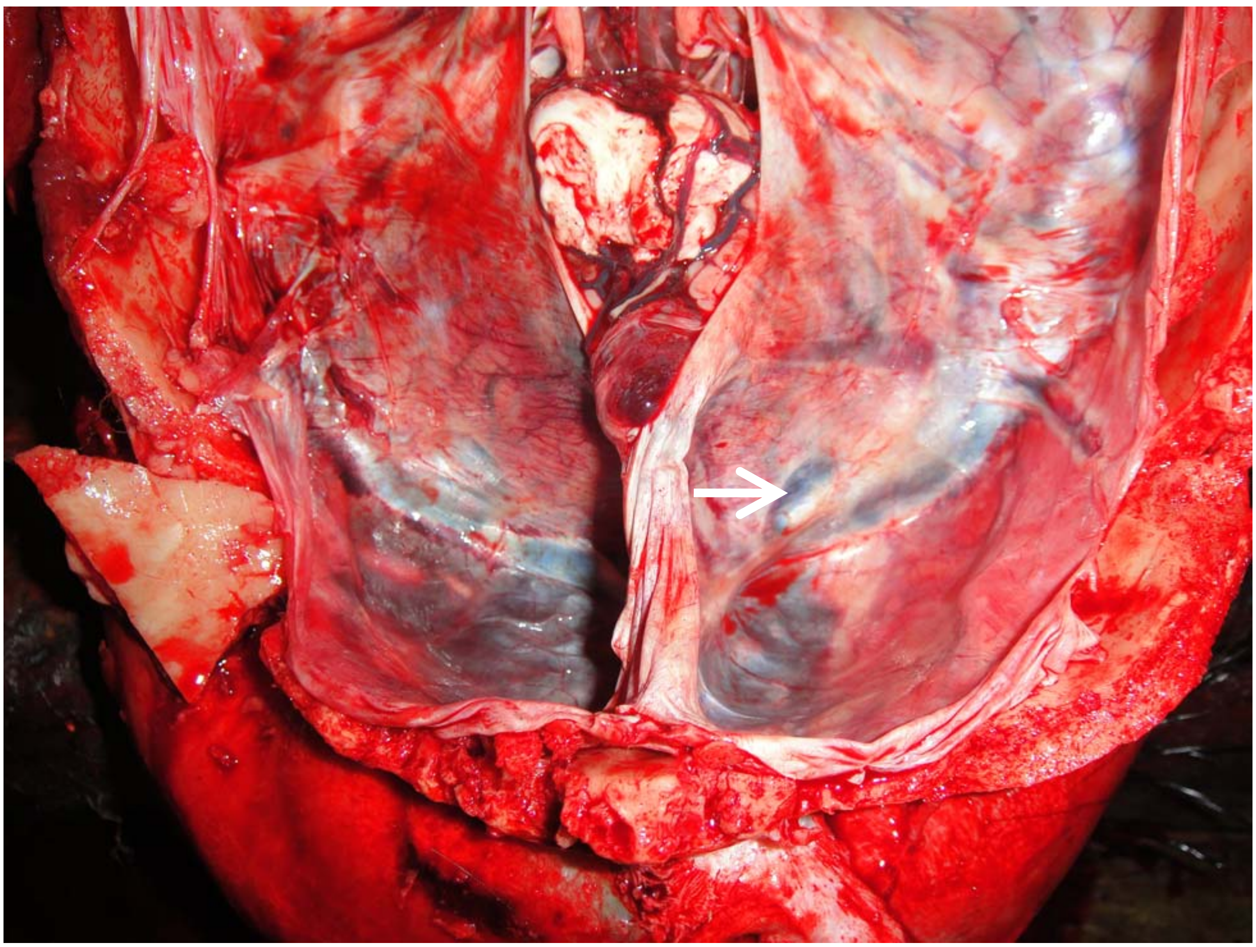
GROUP1: VENOUS SINUSES IN MEDIAL ONE-THIRD OF TENTORIUM CEREBELLI

Type b: Sinuses draining into torcular sinus

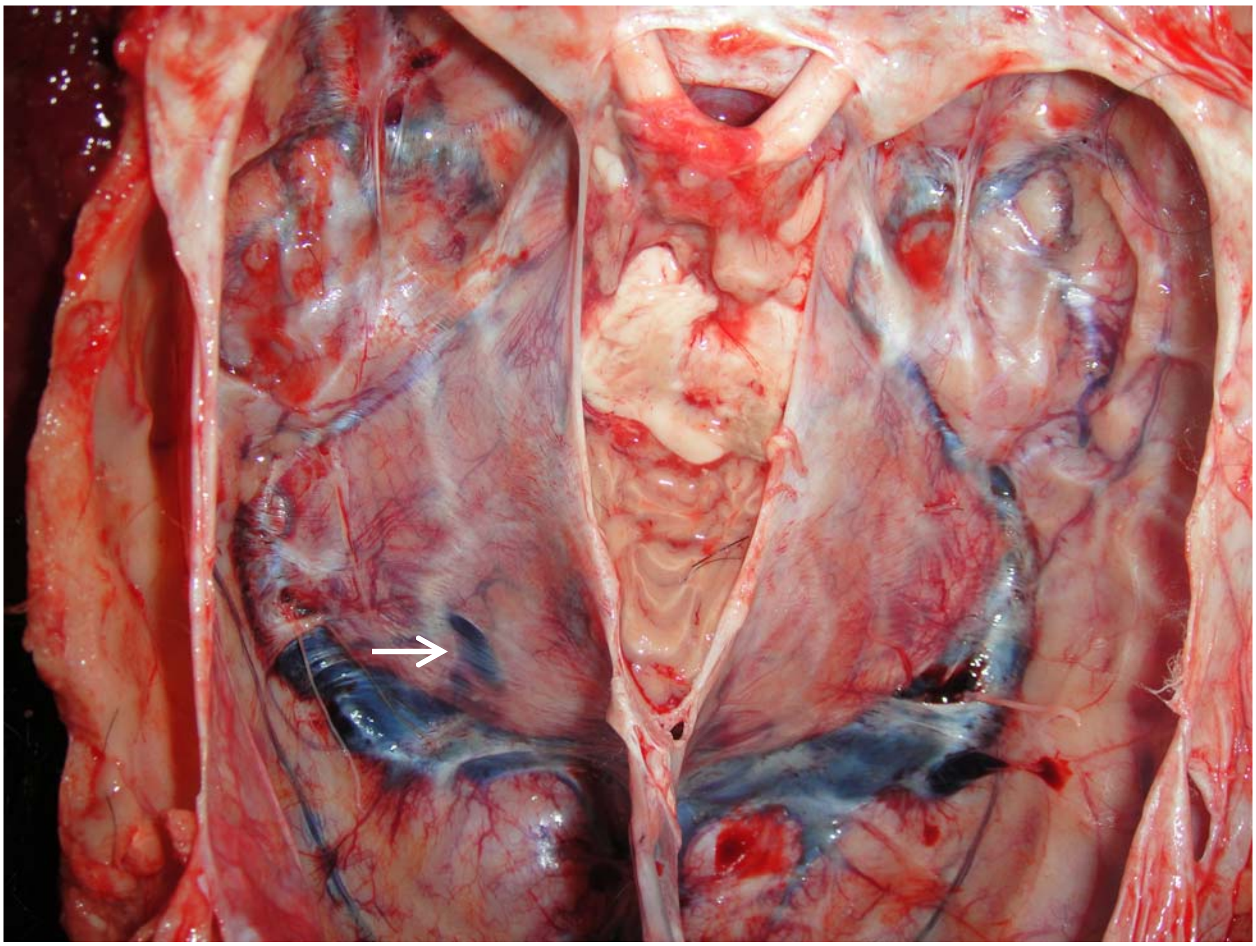


GROUP 1: VENOUS SINUSES IN MEDIAL ONE-THIRD OF TENTORIUM CEREBELLI

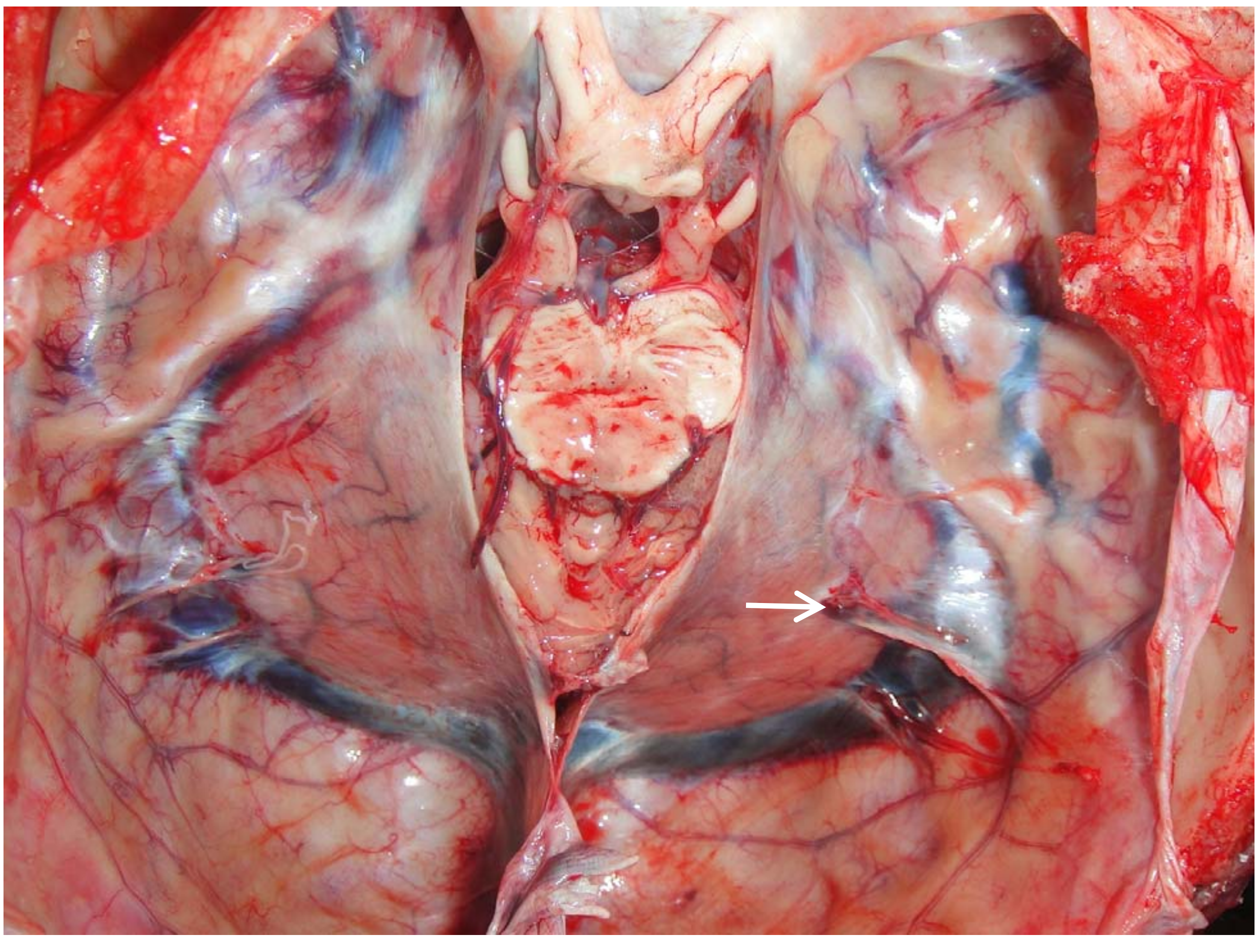
Type c: Sinuses draining into medial one-third of transverse sinus



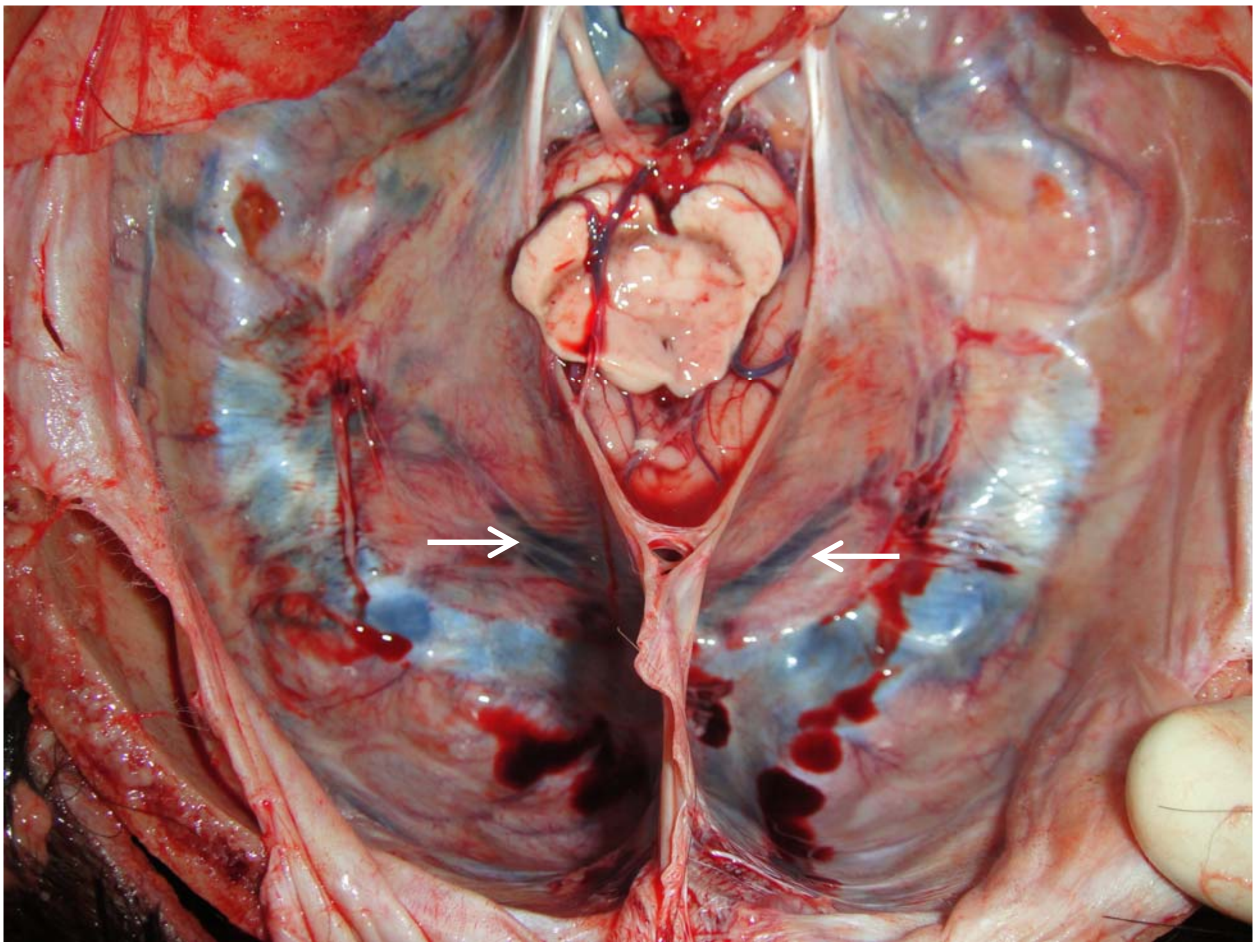
GROUP 2: VENOUS SINUSES IN MIDDLE ONE-THIRD OF TENTORIUM CEREBELLI



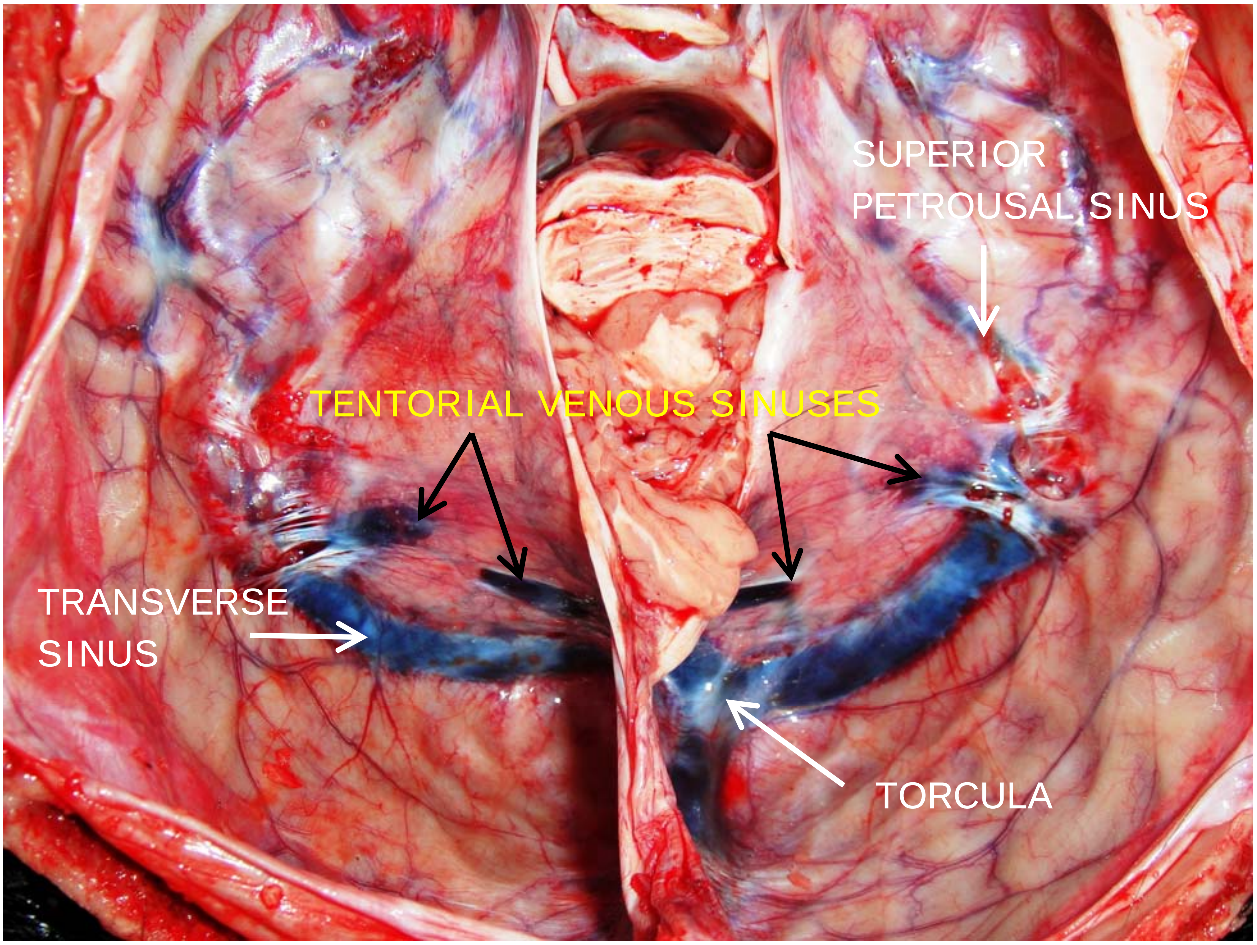
GROUP 3: VENOUS SINUSES IN LATERAL ONE-THIRD OF TENTORIUM CEREBELLI



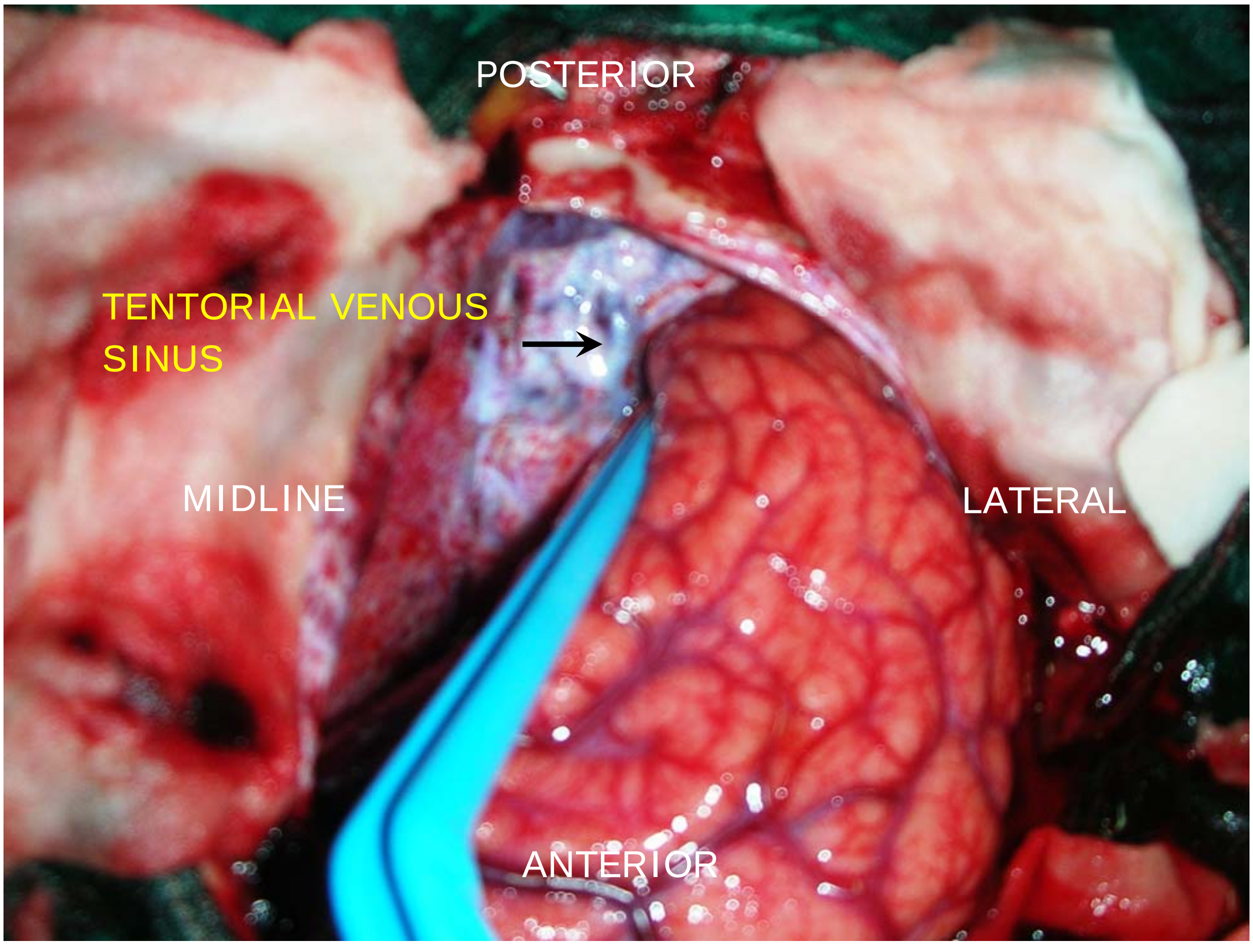
GROUP 4: VENOUS RING PATTERN



CADAVERIC PICTURE OF TENTORIAL VENOUS SINUS



INTRA OPERATIVE PICTURE OF TENTORIAL VENOUS SINUS



MASTER CHART

S.no	Name	Age	sex	No. of sinuses			Group 1			Group 2	Group 3	Group 4
				left	Right	total	Type a	Type b	Type c			
1	Kumarasamy	48	M	1	-	1	-	1	-	-	-	-
2	Maheswari	34	F	1	-	1	-	-	-	-	1	-
3	Iyyapan	52	M	1	-	1	-	-	-	1	-	-
4	Balaji	21	M	2	1	3	-	2	-	-	1	-
5	Sekar	51	M	1	1	2	2					
6	Anbu	37	M	-	1	1	-	-	1	-	-	-
7	Raju	65	M	1	1	2	-	2	-	-	-	-
8	Lakshmi	45	F	1	1	2	-	-	-	-	2	-
9	Aadhi nayagam	32	M	1	-	1	-	-	-	-	1	-
10	Deivaniammal	55	F	-	1	1	-	-	-	-	1	-
11	Karthik	25	M	-	1	1	-	-	1	-	-	-
12	Karruppu	55	M	-	-	-	-	-	-	-	-	-
13	Murugan	63	M	-	1	1	-	1	-	-	-	-
14	Krishnaveni	29	F	2	2	4	-	2	-	-	2	-
15	Rajaram	38	M	1	-	1	-	-	-	-	-	1
16	Jawahar	45	M	1	-	1	-	-	-	1	-	-
17	Thenmozhi	27	F	1	2	3	1	-	-	-	2	-
18	Rani	36	F	1	1	2	-	-	-	-	2	-

19	Vennila	32	F	1	-	1	-	1	-	-	-	-
20	Devendhiran	44	M	1	1	2	-	2	-	-	-	-
21	Petchiammal	65	F	-	1	1	-	-	-	-	1	-
22	Murugeswari	54	F	2	2	4	-	2	-	-	2	-
23	Kottai muthu	60	M	-	1	1	-	1	-	-	-	-
24	Ramasubbu	60	M	-	-	-	-	-	-	-	-	-
25	Kuruvammal	67	F	2	1	3	2	-	-	-	1	-
26	Pandi	40	M	1	-	1	-	-	-	-	1	-
27	Eswari	40	F	1	1	2	1	1	-	-	-	-
28	Selvarajan	52	M	1	-	1	-	-	-	1	-	-
29	Sagundala	55	F	1	-	1	-	-	-	-	-	1
30	Pattathu rani	25	F	1	-	1	-	1	-	-	-	-
31	Murugeswari	21	F	1	-	1	-	-	-	-	1	-
32	Palani	36	M	-	-	-	-	-	-	-	-	-
33	Meenatchi	33	F	2	2	4	2	-	-	-	2	-
34	Murugananthan	40	M	2	1	3	2	-	-	-	1	-
35	Saravanan	54	M	-	1	1	-	-	-	-	-	1
36	Gejalakshmi	61	F	1	-	1	-	-	-	1	-	-
37	Annammal	29	F	1	1	2	-	-	-	2	-	-
38	Magesh	36	M	-	-	-	-	-	-	-	-	-
39	Pandiyan	56	M	1	2	3	-	1	-	-	2	-
40	Moorthi	61	M	-	-	-	-	-	-	-	-	-
41	Chandran	47	M	1	1	2	1	-	-	-	1	-
42	Anjalai	60	F	-	1	1	-	-	-	-	1	-

43	Papa	58	F	1	-	1	-	-	1	-	-	-
44	Rajagopal	53	M	1	1	2	1	1	-	-	-	-
45	Palanivel	46	M	2	1	3	-	2	-	-	1	-
46	Gurusamy	66	M	1	-	1	-	-	-	-	1	-
47	Ibrahim	30	M	1	-	1	-	1	-	-	-	-
48	Kumaresan	59	M	1	1	2	1	-	-	-	1	-
49	Latha	36	F	-	1	1	-	-	-	-	1	-
50	Kuppammal	65	F	1	-	1	-	1	-	-	-	-
51	Vellayan	68	M	2	2	4	-	2	-	-	2	-
52	Raman	68	M	2	1	3	-	1	-	-	2	-
53	Ganesan	42	M	-	-	-	-	-	-	-	-	-
54	Uma	38	F	1	1	2	-	1	-	-	1	-
55	Loganayaki	65	F	-	1	1	-	-	-	-	1	-
56	Babu	41	M	1	-	1	-	-	-	-	1	-
57	Sagayam	48	M	1	1	2	-	-	-	2	-	-
58	Rajalakshmi	30	F	1	-	1	1	-	-	-	-	-
59	Indirani	47	F	1	-	1	-	-	-	1	-	-
60	Akilandam	60	F	1	-	1	-	-	1	-	-	-
61	Perumol	65	M	1	2	3	2	-	-	-	1	-
62	Suseela	22	F	-	1	1	-	1	-	-	-	-
63	Balakrishnan	70	M	1	-	1	-	-	-	-	1	-
64	Chinnasamy	46	M	1	1	2	-	2	-	-	-	-
65	Mumthajbanu	45	F	-	1	1	-	1	-	-	-	-
66	Kalidoss	52	M	2	2	4	2	-	-	-	2	-

67	Ahamed	21	M	-	-	-	-	-	-	-	-	-
68	Jeysankar	54	M	1	-	1	-	-	-	-	1	-
69	Rengan	45	M	2	1	3	-	1	-	-	2	-
70	Vellimalai	55	M	1	-	1	-	1	-	-	-	-
71	Pounthai	30	F	-	1	1	-	-	-	-	1	-
72	Nagammal	49	F	-	1	1	-	1	-	-	-	-
73	Prabakaran	57	M	-	-	-	-	-	-	-	-	-
74	Anthonisamy	62	M	1	1	2	-	-	-	-	-	2
75	Isakimuthu	51	M	1	1	2	-	-	-	-	2	-
76	Valarmathi	45	F	1	-	1	1	-	-	-	-	-
77	Chinnaponnu	64	F	1	-	1	-	1	-	-	-	-
78	Vignesh	27	M	1	-	1	-	-	1	-	-	-
79	Muniyandi	48	M	-	1	1	-	-	-	-	1	-
80	Kannan	53	M	1	-	1	-	-	-	1	-	-
81	Kaja	39	M	-	1	1	-	-	-	-	1	-
82	Vijaya	44	F	1	-	1	-	1	-	-	-	-
83	Selvi	33	F	1	2	3	-	1	-	-	2	-
84	Dharmar	57	M	1	-	1	-	-	-	-	1	-
85	Egambaram	66	M	-	-	-	-	-	-	-	-	-
86	Elumalai	42	M	1	-	1	1	-	-	-	-	-
87	Paraman	60	M	1	-	1	-	-	-	-	1	-
88	Vellayammal	38	F	1	1	2	-	-	-	-	-	2
89	Jeevananthan	55	M	1	-	1	-	-	1	-	-	-
90	Maheswari	23	F	-	1	1	-	-	-	-	1	-

91	Rajamani	25	F	1	-	1	-	-	-	-	1	-
92	Kalimuthu	44	M	1	1	2	-	1	-	-	1	-
93	Rohini devi	21	F	2	1	3	-	2	-	-	1	-
94	Vanathi	32	F	-	1	1	-	-	-	-	1	-
95	Marimuthu	30	M	-	1	1	1	-	-	-	-	-
96	Chitra	42	F	-	1	1	-	-	-	-	-	1
97	Dhanasekaran	53	M	1	-	1	-	-	1	-	-	-
98	Durairaj	64	M	-	1	1	-	1	-	-	-	-
99	Murugan	25	M	1	-	1	-	-	-	-	1	-
100	Rajammal	52	F	-	1	1	1	-	-	-	-	-

BIBLIOGRAPHY

1. Muthukumar N, Palaniappan P. Tentorial Venous Sinuses: An Anatomic Study.Neurosurgery. 1998 Feb;42(2):363-71 .
2. Gibbs EL, Gibbs FA: The cross section areas of the vessels that form the torcular and the manner in which flow is distributed to the right and to the left lateral sinus. Anat Rec 59:419-426, 1934.
3. Bull JW: Tentorium cerebelli. Proc R Soc Med 62:1301–1310, 1969.
4. Winslow J B (1732) Expositicn Anatomique de la Structure du Corps Humain. Paris
5. Rhoton AL Jr. Tentorial incisura. Neurosurgery. 2000 Sep; 47(3 Suppl):S131-53.
6. Ono M, Ono M, Rhoton AL Jr, Barry M. Microsurgical anatomy of the region of the tentorial incisura. J Neurosurg. 1984 Feb;60(2):365-99.
7. Plaut hf. Size of the tentorial incisura related to cerebral herniation. Acta Radiol Diagn (Stockh). 1963 May;1:916-28.

8. Padget DH: The cranial venous system in man in reference to development, adult configuration, and relation to arteries. Am J Anat 98:307-355, 1956.
9. Lasjaunias P, Raybaud C: Intracranial venous system, in Lasjaunias P, Bernstein A (eds): Surgical Neuroangiography. New York, Springer-Verlag, 1993, vol 3, pp 223-245.
10. Okudera T, Huang YP, Ohta T, Yokota A, Nakamura Y, Maehara F, Utsunomiya H, Uemura K, Fukasawa H: Development of posterior fossa dural sinuses, emissary veins, and jugular bulb: Morphological and radiologic study. AJNR Am J Neuroradiol 15:1871-1883, 1994.
11. Rhoton AL Jr:Cerebral veins. Neurosurgery 51[Suppl 1]: 159–205, 2002.
12. Matsushima T, Suzuki SO, Fukui M, Rhoton AL Jr, Oliveira ED, Ono M: Microsurgical anatomy of the tentorial sinuses. J Neurosurg 71:923-928, 1989.
13. Al-Mefty O, Fox JL, Smith RR: Petrosal approach for petroclival meningiomas. Neurosurgery 22:51-57, 1988.

14. Hakuba A, Nishimura S, Inoue Y: Transpetrosal-transtentorial approach and its application in the therapy of retrochiasmatic craniopharyngiomas. Surg Neurol 24:405-415, 1985.
15. Kawase T, Shiobara R, Toya S: Anterior transpetrosal-transtentorial approach for sphenopetroclival meningiomas: Surgical methods and results in 10 patients. Neurosurgery 28:868-876, 1991.
16. Browder J, Kaplan HA, Krieger AJ: Venous lakes in the suboccipital dura mater and falx cerebelli of infants: Surgical significance.Surg Neurol 4:53-55, 1975.
17. Yamamoto I, Pineal region tumor: surgical anatomy and approach. Journal of Neuro-Oncology 54: 263–275, 2001.
18. Nagashima H, Kobayashi S, Takemae T, Tanaka Y: Total resection of torcular herophili hemangiopericytoma with radial artery graft: Case report. Neurosurgery 36:1024-1027, 1995.
19. Nakagawa H, Nakajima S, Murasawa A, Niiyama K, Ishiguro S: Papillary meningioma arising from the confluens sinuum with multidirectional extension through venous sinuses. Surg Neurol 32:219-224,1989.

20. Odake G: Meningioma of the falcotentorial region: Report of two cases and literature review of occlusion of the galenic system.Neurosurgery 30:788-794, 1992.
21. Morgan MK: Meningioma of the falcotentorial region: Report of two cases and literature review of occlusion of the galenic system. Neurosurgery 30:794, 1992 (comment).
22. Asari S, Maeshiro T, Tomita S, Kawauchi M, Yabuno N, Kinugasa K, Ohmoto T: Meningiomas arising from the falcotentorial junction: Clinical features, neuroimaging studies, and surgical treatment. J Neurosurg 82:726-738, 1995.
23. Rostomily RC, Eskridge JM, Winn HR: Tentorial meningiomas. Neurosurg Clin N Am 5:331-348,1994.
24. Tanaka Y, Sugita K, Kobayashi S, Hongo K: Straight sinus meningioma. Surg Neurol 24:550-554,1985.
25. Girard N, Lasjaunias P, Taylor W: Reversible tonsillar prolapse in vein of Galen aneurismal malformations: Report of eight cases and pathophysiological hypothesis. Childs Nerv Syst 10:141-47,1994.
26. Lasjaunias P, Ter Brugge K, Lopez Ibor L, Chiu M, Flodmark O, Chuang S, Goasguen J: The role of dural anomalies in Vein of

Galen aneurysms: Report of six cases and review of the literature.AJNR Am J Neuroradiol 8:185-192, 1987.

27. Minakawa T, Tanaka R, Koike T, Takeuchi S, Abe H: Cerebral arteriovenous malformations associated with straight sinus anomaly.Neurosurgery 31:19-24, 1992.

28. Raybaud CA, Strother CM, Hald JK: Aneurysms of the vein of Galen: Embryonic considerations and anatomical features relating to the pathogenesis of the malformation. Neuroradiology 31:109-128,1989.

29. Duckwiler G: Dural arteriovenous fistula. Neuroimaging Clin N Am 2:291-302, 1992.

30. Houser WO, Baker HL, Rhoton AL Jr, Okazaki H: Intracranial dural arteriovenous malformations. Radiology 105:55-64, 1972.

31. Vidyasagar C: Persistent embryonic veins in arteriovenous malformations of the brain. Acta Neurochir (Wien) 40:103-116, 1978.

32. Kaplan HA, Browder J, Kreiger AJ: Venous channels within the intracranial dural partitions. Radiology 115:641-645, 1975.

33. Raybaud CA, Strother CM, Hald JK: Aneurysms of the vein of Galen: Embryonic considerations and anatomical features relating to the pathogenesis of the malformation. Neuroradiology 31:109-128,1989.
34. Cure JK, Van Tassel P, Smith MT: Normal and variant anatomy of the dural venous sinuses. Semin Ultrasound CT MR 15:499-519, 1994.
35. Yokota A, Oota T, Matsukado Y, Okudera T: Structures and development of the venous system in congenital malformations of the brain. Neuroradiology 16:26-30, 1978.
36. Osaka K, Sato S, Yamasaki S, Fujita K, Matsumoto S, Kodama S: Dysgenesis of the deep venous system as a diagnostic criterion for holoprosencephaly. Neuroradiology 13:231-238, 1977.
37. Huang YP, Okudera T, Ohtal T, Robbins A: The torcular, the straight, sagittal, lateral, occipital and tentorial sinuses: The variations and clinical significance, in Kapp JP, Schmideck HH (eds):The Cerebral Venous System and Its Disorders. Orlando, Grune & Stratton, 1984, pp 109-167.

38. Mattel HP, Wentz KU, Edelman RR, Wallner B, Fenn JP, Barnes P, Atkinson DJ, Kleefield J, Hoogewoud HM: Cerebral venography with MR. Radiology 178:453-458, 1991
39. Miabi Z: Delineation of lateral tentorial sinus with contrast-enhanced MR imaging and its surgical implications. AJNR Am J Neuroradiol. 25(7):1181-8, 2004.
40. Bisaria KK: Anatomic variations of the venous sinuses in the region of the torcular herophili. J Neurosurg 62:90-95, 1985.
41. Saxena RC, Beg MAQ, Das AC: Double straight sinus: Report of six cases. J Neurosurg 39:540-542,1973.
42. Oka K, Rhoton AL Jr, Barry M, Rodriguez R: Microsurgical anatomy of the superficial veins of the cerebrum.Neurosurgery 17:711-748, 1985.
43. Koperna TH, Tschabitscher M, Knosp E: The termination of the vein of Labbe and its microsurgical significance. Acta Neurochir (Wien) 118:172-175, 1992.
44. Jin DK, Yoon SH, Choi JU, Lee HY, Chung IH: The Normal Variation of Tentorial Sinuses Draining into the Straight Sinus. J Korean Neurosurg Soc. 1994 Jun;23(6): 681-684.